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SOME ENDOCRINE RELATIONSHIPS IN NUTRITIONAL REPRODUCTIVE FAILURE (A REVIEW)

H. R. GUILBERT
University of California[1]

Introduction

THE livestock industry is familiar with the wide and economically significant variations in reproductive output of domestic animals that result from good and poor environmental conditions. The cyclical abundance and scarcity of species in nature in response to favorable and unfavorable environment have long aroused scientific interest and speculation concerning the specific causes and mechanisms that are involved.

Julian Huxley (1927) has cited some of the outstanding examples of these periodic outbursts of generative energy.

The lemming of Scandinavia was cited as the best known example of cyclical abundance. This animal of the mountains of Southern Scandinavia becomes so abundant every few years that the young animals set off on migrations in all directions in enormous numbers. If they come to the sea, they enter the water and swim out until they drown, the coast becoming strewn with their corpses. Other sorts of animals show the same rise and fall in numbers, among which are the crossbill bird of the pine forests of Central Europe and the Pallas sand grouse of the steppes and deserts of Central Asia. Very interesting data were obtained from the Hudson Bay Company, which has kept records since 1825 of the number of skins of the various kinds of fur-bearing animals brought in each year by their trappers. These show cycles of abundance and scarcity in muskrat, Canadian rabbit, skunk, fisher, mink, wolverene, marten, lynx, red fox and arctic fox. The record for lynx, for example, varies from 30,000 to 70,000 at the peak to below 5,000 for the depressions. The very large numbers are obtained because the animals are reproducing faster. For example, the Canadian rabbit in bad years produces only one brood of about three young, while in good years it produces two or three broods with eight or ten young in each brood. Conditions favorable for the growth of plants will result in favorable food supply and increase in the small herbivorous animals, and these in turn by furnishing food supply to the carnivorous animals will cause an abundance of these species. Huxley states "We know of no single case of an animal changing its reproductive capacity, whether number of broods per year, or number of young per brood,

[1] Department of Animal Husbandry, College of Agriculture: Davis, Calif.

so long as it is kept under really uniform conditions, while we know of a great many cases in which improved conditions of temperature, food, etc., do bring about an increase in reproductive output."

Temperature, food supply, predators and disease are doubtless the primary factors controlling populations in nature. The response of both wild and domestic animals to food supply is so marked that it is logical to inquire whether nature has provided animals with a protective mechanism for limiting or prohibiting reproduction under adverse conditions that is useful for species survival.

Relation of Nutrition to Reproduction

The relation of diet to reproduction has recently been reviewed by Phillips, Friedman and Turner (1939). Some of the pertinent information is summarized as follows:

Inanition in rats induced by reducing food intake 20 to 30 per cent below that voluntarily eaten adversely affects reproduction. Food restriction that causes marked growth retardation in young or weight losses in adults results in cessation of estrus in the female, loss of sexual libido and motility of sperm, and testicular atrophy in the male. Anestrus often develops with a weight loss of only 15 per cent (Evans and Bishop, 1922) (Macomber, 1933) (Asdell and Crowell, 1934) (Marrian and Parkes, 1929) (Mason, 1933). There is evidence of similar results in domestic livestock though clear-cut data are lacking in regard to how much weight must be lost or the degree of food restriction necessary to produce these effects.

Phosphorus and vitamin "B complex" deficiencies likewise result in these same manifestations (Evans, 1928) (Guilbert and Hart, 1930) Hart, 1931) (Theiler and Green, 1932) (Kleiber, Goss and Guilbert, 1936). Since these and other deficiencies decrease appetite, it is difficult, if not impossible, to study the deficiency uncomplicated by inanition, and for the present we assume that any deficiency that affects appetite affects reproduction through coincident general undernutrition.

Protein deficiency likewise causes cessation of ovulation in the female and lack of sexual desire in male rats (Guilbert and Goss, 1932). Some evidence of irregularity of estrus has been obtained with cattle on low protein intake. A protein deficient ration fed to ewes during the breeding season resulted in low percentage lamb crop (Hart and Miller, 1937). Pearson (1937, 1937a) and Courrier and Raynaud (1932) showed that lysine deficiency produced similar effects. Protein deficiency also affects appetite, but in some of the rat experiments of Guilbert and Goss (1932) estrous cycles ceased while food intake was practically normal and the rats were fat and nearly normal in weight. It was found, furthermore, that rats on a level of protein intake

that permitted more or less regular estrous cycles as determined by vaginal smears, produced no litters. Failure was caused by (a) failure to mate, (b) infertile matings, and (c) fertile mating followed by death of the embryos. Thus several types of failure resulted from different degrees of the same deficiency.

Vitamin A deficiency results in the death of the fetus or in birth of nonviable young and in testicular degeneration. Ovulation occurs regularly until advanced stages of deficiency. Pregnancy has been more or less regularly established in rats at a level of deficiency which is manifested by continuously cornified vaginal smears (Evans and Bishop, 1922a) (Mason, 1933) (Hart and Guilbert, 1933) (Guilbert and Hart, 1933, 1935) (Mason and Ellison, 1935, 1935a) (Meigs, 1938). We have not observed establishment of pregnancy in cows or pigs below the borderline of deficiency though matings occurred. Sheep have become pregnant at about the borderline level (Hart and Miller, 1937). It would be expected that abnormal condition induced in the vaginal and uterine mucosa would militate against fertilization. There is abundant evidence that the ovary and ova are not impaired in the earlier stages of deficiency.

Iodine deficiency in animals causes reproductive failure primarily through development of goitrous condition in the developing fetus.

Manganese deficiency causes testicular atrophy, infantile mortality, and deformity. The estrous cycle apparently is not affected (Orent and McCollum, 1931) (Skinner, Van Donk, Evelyn and Steenbock, 1932) (Daniels and Everson, 1935).

Essential fatty acid deficiency eventually causes cessation of estrus when the animals show clinical symptoms and poor general health. Supplying the essential fatty acids is reported to restore estrous cycles before significant recovery in general health is attained (Burr and Burr, 1930). Maeder (1937) reported that ovulation in rats was affected late in the course of fat deficiency but impaired reproductive ability occurred early. Atrophic changes in the maternal decidua, resorptions or prolonged gestations similar to that described by Mason (1935) in vitamin A deficiency were observed. Similar to vitamin A deficiency fetal death was secondary to placental injury. Large, pale, chalky ovaries showing vacuolization and coarse granulation similar to the condition described by Evans and Lepkovsky (1934) were found. Some cases indicated that irreparable damage to reproduction occurred although external clinical symptoms disappeared with fat feeding. Sherman (1941) has reported experiments with rats that indicate a relation between essential fatty acids and carotene utilization.

Vitamin E deficiency in the rat causes irreversible damage to testicular germinal epithelium and destroys the fetus through its effect on mesodermal

tissues, the hematopoietic system and other rapidly differentiating tissues (Evans and Burr, 1927) (Mason, 1933).

The Endocrine System Concerned with Reproduction

That part of the reproductive endocrine system essential to the present discussion together with the points in the system affected by various nutritional deficiencies is presented in schematic form in figure 1. As indicated in figure 1, gonadotropin from the anterior pituitary acts upon the ovaries to

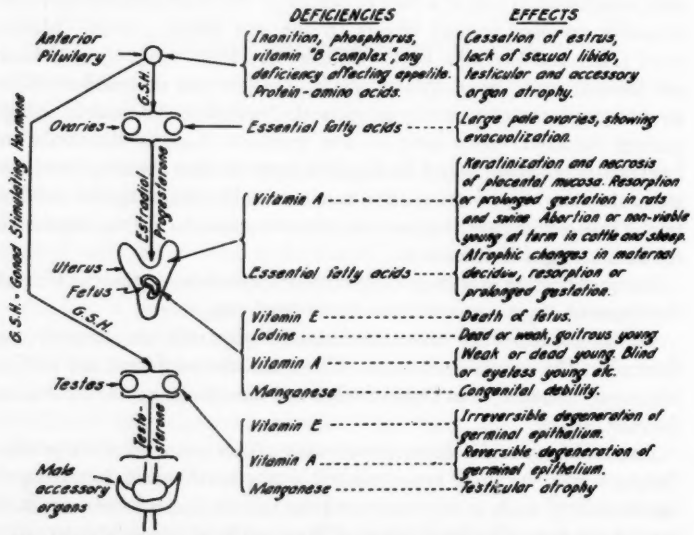

Figure 1. A schematic presentation of the reproductive-endocrine system together with the effects of various nutritional deficiencies.

stimulate growth and maturation of follicles and finally the formation of corpora lutea. Possibly two gonadotropins are involved in producing this response (Fevold, 1939). Under this stimulation the ovary produces estradiol which prepares the vagina for copulation and initiates growth changes preparatory to implantation in the uterus. Corpus luteum elaboration of progesterone in turn continues this preparation of the uterus for implantation and maintenance of pregnancy. Gonadotropin in the male activates sperm production and testicular interstitial tissue which in turn produces testosterone that stimulates the male accessory organs. These relationships are well established but by no means constitute the whole of the complex interdependencies that regulate reproduction in the normal individual.

Though the effect of gonads on the pituitary and effects of suprarenal and other endocrine secretions are recognized, this simplified picture is considered to suffice for this discussion of nutritional and endocrine relationships.

Evidence of Endocrine-Nutritional Relationships

Jackson (1925) from his studies on inanition suggested "that changes produced in the hypophysis may be responsible for some of the general phenomena of inanition and malnutrition." When the importance of the hypophysis as a "master gland" began to be understood, it became more or less customary for nutrition workers to advance the idea that any repoductive disturbance induced by dietary regimen acted in some way through the anterior pituitary. Some of these hypotheses were made advisedly; others have little basis for support.

Asdell (1931) states: "An observation by Hammond and Asdell which has been confirmed by others shows that whatever the amount of ovarian tissue present, the normal animal tends to produce a constant number of ripe ova at one time so it looks as if the anterior lobe hormone is normally present in a limited amount and if more is supplied greater ovarian response occurs. In other words, there is a quantitative relationship between the anterior lobe and the ovary that determines the fecundity of the species." Production of normal numbers of ova in the remaining ovary after unilateral ovarectomy may be cited as an example. If more than a normal amount is supplied by artificial means, superovulation occurs and superfecundity in immature rats has been produced (Cole, 1937). If less than normal is produced through unfavorable environment or other causes, less than normal or no ovulation occurs.

Inanition. The evidence at present indicates that inanition *per se* or lack of any factor that decreases appetite acts through the pituitary.

Mulinos and Pomerantz (1940) suggest that the mode of action could be visualized essentially as follows:

1. General undernutrition affects in some degree all cells and organs of the body. The effect on the pituitary gland could result in decreased hormone secretion
2. Decreased hormone secretion of the pituitary would affect secondarily dependent glands such as the ovaries or testes in addition to the general effect of the inanition on these tissues.
3. This double effect on the testes, for example, would have an even greater effect upon the accessory reproductive organs that depend on testes secretion.

The following evidence indicates that this type of mechanism actually

occurs in the case of inanition, deficiencies that depress appetite and possibly a specific effect of protein deficiency.

Mulinos and Pomerantz (1940) demonstrated that the histological changes occurring in the adrenal, thyroid, spleen, liver, ovaries and testes in inanition were similar to those that occur after hypophysectomy. Food consumption also decreases in the rat following hypophysectomy, a fact which complicates interpretation of results. Nevertheless these authors believe many of the effects of inanition are due to the malnutrition of the pituitary resulting in diminished hormone secretion. They also show that the pituitary loses more in weight than the body as a whole during inanition and that it shows atrophic changes. Decreased hormone content of the pituitary during undernutrition has been reported by Cole, Guilbert and Goss (1932) and Werner (1939). Deficiency of pituitary hormone secretion during dietary anestrus and impotency is further substantially supported by the fact that introduction of the hormone through gland implants, injection of pituitary gonadotropin, chorionic gonadotropin, or injection of equine gonadotropin restores ovarian and testicular function in underfed animals (Marrian and Parkes, 1929) (Cole, Guilbert and Goss, 1932) (Stephens and Allen, 1941) (Mulinos and Pomerantz, 1941).

Protein. Deficiency of dietary protein also commonly decreases appetite and thus may affect estrus and sexual libido through the inanition so produced. That reproductive failure from protein or amino acid deficiency involves pituitary insufficiency is indicated by the fact that ovarian and testicular activity is restored by gonadotropic hormone therapy (Cole, Guilbert and Goss, 1932) (Courrier and Raynaud, 1932). The former workers also found that the pituitaries of protein deficient rats were greatly reduced in size and that they elicited less ovarian response than normal glands when implanted into immature female rats.

That protein deficiency may have some specific effect on the pituitary is suggested by the experiments of Guilbert and Goss (1932) in which ovulation ceased in some of the rats that were fat and nearly normal in weight. Furthermore, Cole, Guilbert and Goss (1932) observed the occurrence of retained corpora lutea in protein-deficient rats similar to that occurring after hypophysectomy. The ovary in phosphorus deficiency becomes quiescent and infantile (Guilbert and Hart, 1930) (Kleiber, Goss and Guilbert, 1936) and likewise in most cases of inanition (Mulinos and Pomerantz, 1940). Popoff and Okutilschew (1936) reported that the amount of protein in the ration affected the amount of semen and sperm produced and the vigor of sperm in sheep.

Carbohydrates. Evans and Bishop (1922) found that the absence of dietary carbohydrates did not appreciably affect the regularity or frequency of

estrous cycles in the rat. Whitnah and Bogart (1936) reported normal reproduction in rats on a diet consisting of corn starch, yeast, salt mixture, butter fat, casein and codliver oil and on the same diet with 20 per cent of starch replaced by lactose. When 20 per cent sucrose replaced starch, precocious sexual maturity occurred which was followed by sterility. The ovaries were characterized by extreme luteinization of unruptured follicles and by persistent corpora lutea. These ovarian abnormalities indicate pituitary disturbance difficult to explain from a nutritional standpoint and must await further work before the results can be evaluated.

Essential fatty acids. Burr and Burr (1930) suggest the possibility that essential fatty acids are necessary to the synthesis of male and female sex hormones that are lipoid in nature. Maeder (1937) demonstrated atrophic changes in the maternal decidua, preceding fetal injury, resulting from fat deficiency that are similar to those of vitamin A deficiency. The characteristic histological changes found in the ovary also indicated a direct effect of essential fatty acids upon this tissue. Although it is not clear that uterine changes are the result of impaired hormone secretion, it does not appear probable that the ovaries described could function normally.

Manganese. Orent and McCollum (1931) reported testicular degeneration in male rats and 100 per cent mortality in the young of mothers fed on a diet spectroscopically free from manganese. Regularity of estrous cycle in the female was not affected. In later work at Wisconsin in which milk supplemented with copper and iron constituted the low manganese ration, estrus cycles were affected. Subsequently this was shown to be caused by the low energy intake on the milk diet and was corrected by sucrose supplement (Skinner, Van Donk and Steenbock, 1932). It appears, therefore, that the effect on the testes is direct rather than through the pituitary as originally suggested by Orent and McCollum because estrous cycles in the female are not affected by the deficiency and both testicular and ovarian activity are stimulated by the same pituitary hormone.

Vitamin A. Evans and Bishop (1922a) and Mason and Ellison (1935) have shown that estrous cycles regularly occur in the vitamin A deficient rat even though the characteristic cyclical changes in the vagina are obscured by continuously cornified vaginal smears. We have made similar observations with regard to recurrence of estrus in larger animals in all but later stages of deficiency. Sexual libido is likewise retained by the male until testicular atrophy has advanced and/or appetite has declined (Howell, Hart and Ittner, 1941). The changes in the testes, though resembling those produced by inanition and by hypophysectomy, differ in the continuance of some spermatogenesis in spite of considerable depletion of germinal epithelium in vitamin A deficiency compared with the more general inactive state of the

tissues of inanition (Mason, 1933). Sutton and Brief (1939) showed that the change in size, hormone content and histological appearance of the anterior pituitary accompanying testicular atrophy of vitamin A deficiency were identical with those of castration. These findings are evidence of direct effect on the testes and that the pituitary is not primarily involved in vitamin A deficiency.

Vitamin A deficiency affects reproduction in the female either through changes in the vaginal and uterine mucosa which may interfere with fertilization or by causing death of the fetus. The latter is the more commonly occurring type of failure. In the rat and presumably in the cow and other animals keratinization and necrosis of the placental membranes precede changes in fetal tissues. That the fetus itself may be directly affected is shown by birth of blind calves and birth of pigs without eye balls and with cleft palates (Guilbert and Hart, 1935) (Hale, 1935).

Vitamin E deficiency causes irreversible damage to the testes of male rats and death of the fetus in utero. In vitamin E deficiency, changes in the fetus and its death precede any placental injury. Mesodermal tissues and the hematopoietic system are especially affected in vitamin E deficiency while epithelial structures are conspicuously involved in vitamin A deficiency (Mason, 1935).

Discussion

Lack of evidence of requirement for vitamin E, and rumen synthesis of vitamin "B complex" considerably limit the list of deficiencies apt to be encountered in ruminants. Phillips et al (1940) have presented evidence of reestablishing potency and sperm vitality in bulls by subcutaneous injection of ascorbic acid. They have indicated that there is a relationship between ascorbic acid content of semen and the vigor of sperm. The synthesis of ascorbic acid by domestic animals normally in sufficient quantity for ordinary needs would appear to place the success of vitamin C therapy in these reproductive failures in a category somewhat different from the ordinary conception of deficiency. The explanation for the results secured, the mode of action or the interrelation of vitamin C with deficiency of other dietary factors does not at the moment seem clear.

Insofar as cattle and sheep are concerned, it appears that the principal deficiency influencing reproduction in addition to vitamin A abortion and localized iodine deficiency is general undernutrition due to feed shortage or extremely poor quality feed, usually complicated by protein deficiency and not infrequently by phosphorus deficiency. Present evidence points to the anterior pituitary as the mechanism which makes the reproductive process more sensitive than other physiological functions to these deficiencies.

A kind of undernutrition resulting from the drain of lactation does not seem adequate to explain the usual suppression of estrus in swine and rats liberally fed during lactation. This tendency is strong in these species even though the number of young is reduced and the animals actually gain in weight. It is interesting nevertheless that the curve of weight loss of a full-fed sow suckling a large litter is not essentially different from that which will quickly stop estrus in an under-fed rat. The effect on estrous cycle of duplication of this weight loss in sows should be an interesting experiment. Though the mechanism of ovarian suppression in these species is not clear, it is easy to see how lactation coupled with inadequate nutrition affects reproductive ability of cows, a condition which is particularly manifested by first calf heifers that also have strong stimulus for growth.

More definitely defined outward indices of adequate nutrition such as normal weight and condition of breeding animals and the percentage deviations from this normal that are compatible with efficient reproduction are needed. Perhaps the degree of negative nutritional balance is equally or even more important than actual deviation from normal weight. It is not uncommon to observe very thin animals coming into estrus after positive nutritional balance has been established.

More feeding experiments conducted on the basis of furnishing the minimum of whatever kinds and amounts of feeds necessary to obtain definite objectives of well being for breeding animals rather than simply studying the effect of an arbitrarily determined amount of feed appear desirable.

The effects of essential fatty acid deficiency in rats during gestation are extremely interesting. The possibility that certain cases of so-called "dry feed" abortion, not explained by vitamin A deficiency nor by infection, might be caused by fat deficiency warrants investigation. The existence of significant amounts of these relatively labile compounds in vegetative portions of mature, dry annual range forage after continual bleaching and oxidation under the influence of sunlight and heat, appears remote. Perhaps some interrelation exists between essential fatty acid and vitamin A deficiencies.

In this country there are extremes of topography, elevation, water supply, climatic conditions and soil conditions that affect plants and animals. In localities of limited or wide extent and in different seasons or years, variations occur that markedly affect reproduction, growth and development of livestock. These constitute natural experiments, the cost of which is beyond the resources of our Experiment Stations. This has been recognized for a long time and was the origin of the statement of Theobald Smith, "that the place to study abnormalities in livestock is where they occur under natural conditions." Animal husbandmen are, therefore, in an ideal situation to add scientific knowledge to the fields of physiology and nutrition by carefully

observing and recording local conditions that are constantly occurring within the borders of our respective states.

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GRAZING WINTER WHEAT WITH SPECIAL REFERENCE TO THE MINERAL BLOOD PICTURE

WARREN N. McMILLEN and WRIGHT LANGHAM
Panhandle Agricultural Experiment Station[1]

THROUGHOUT the Southern High Plains green wheat is the principal winter pasture. As reported by Swanson (1935), in favorable years it may be grazed from two to five months without decreasing the grain yield. Farmers and ranchers rate it equal, or superior, to the native grasses as a pasture crop. Chemical analyses show it to be an excellent source of protein, calcium, phosphorus, magnesium, and carotene.

Death losses occur from time to time in cattle grazing wheat. Bloat occurs following rains and snows (Swanson, 1935) and milk fever has been observed in relatively poor milk producers. It is possible that grass-tetany has also caused losses in range cattle grazing wheat pasture. This condition has become known locally as wheat poisoning and protein poisoning, the latter name resulting from the belief that the condition is the result of the high protein content of growing wheat.

From general observation it seems that the frequency of occurrence of these losses on wheat is related to the state of nutrition of the animal when put on wheat pasture. It is commonly thought that summer droughts resulting in poor summer pasture increase the susceptibility of animals to disorders while grazing wheat. High death rates have been noted in cattle shipped in from drought stricken areas of New Mexico and Arizona.

Intravenous injection of calcium gluconate has proved an effective remedy for both milk fever and grass-tetany in cattle grazing wheat pasture. Stricken cattle in large pastures, however, often die before they are discovered. For this reason a means of preventing such losses is of vital interest.

Because of the uncertainty of the causes and prevention of disorders occurring in cattle on wheat pasture, some preliminary wheat grazing studies were begun during the 1940–41 grazing season. Since few data are available regarding the performance of beef cattle grazing wheat in this area, records of gains of calves used in the experiment are included in this study.

Materials and Methods

Three lots of five grade Hereford steer calves and two lots of seven grade Hereford heifer calves were divided into lots according to size and mineral blood picture January 28. These calves were shipped in from northeastern

[1] Goodwell, Oklahoma.

New Mexico. They had been weaned about 40 days and were on a ration of cane fodder free-choice and 0.75 pound cottonseed meal for 30 days preceding the initial weigh date. Weights were taken three days in succession to establish the initial weight and the cattle were placed on the following rations January 29, the second day of the initial weighing period:

Lot 1 (7 heifers) was fed an average dry-lot, wintering ration consisting of 5 pounds African millet silage, 4.34 pounds sumac cane fodder, 0.75 pound soybean oil meal and 1.25 pounds milo grain. Salt, bone meal and ground limestone were fed free-choice in separate compartments of a mineral box.

Lot 2 (5 steers) was placed on a two-acre wheat pasture with sumac cane fodder, salt, bone meal and ground limestone fed free-choice.

Lot 3 (5 steers) was placed on a two-acre wheat pasture and given access to bone meal, ground limestone and salt free-choice.

Lot 4 (5 steers) was placed on wheat pasture with no mineral supplement or dry feed.

Lot 5 (7 heifers) was placed on wheat pasture with no mineral supplement or dry feed.

At intervals of about 14 days all calves were weighed and blood samples taken for the determination of serum calcium, phosphorus and magnesium. Serum calcium was determined by a slight modification of the method of Clark and Collip (1925), serum phosphorus by the Benedict method and serum magnesium by the method suggested by Eveleth et al (1940).

From February 27 to March 3 and again from March 25 to March 31 it was necessary to remove all animals from wheat pasture because of heavy snow. During the time the animals were in dry-lot they were fed sumac cane fodder without any supplement.

Periodically, samples of growing wheat were taken and analyzed for moisture, protein, ash, phosphorus, calcium and magnesium. The methods used were essentially those recommended by the Association of Official Agricultural Chemists (1935).

In order to obtain a more definite idea of the blood mineral level of animals stricken with milk fever and grass-tetany resulting from grazing wheat pasture, every opportunity was utilized to obtain blood samples from cases occurring within the immediate vicinity of the experiment station. Samples were taken before treatment with calcium gluconate and again 24 hours after treatment in the hope of obtaining information concerning the action of calcium gluconate in alleviating the conditions.

Results and Discussion

The initial and periodic weights for each of the five lots are shown in table 1. The control lot (No. 1) of seven heifers averaged 1.12 pounds daily

gain for 106 days on the dry-lot wintering ration. They outgained the calves on wheat pasture for the 75 day period up to April 16 and probably would have continued to do so had the ration been increased as the calves grew larger. During the 106 days the seven heifers consumed 6 pounds ground limestone, 6 pounds bone meal and 13 pounds salt.

TABLE 1.—PERIODIC WEIGHTS (IN POUNDS) OF HEREFORD CALVES

Date	Lot 1 Dry lot	Lot 2 Wheat pasture, mineral and dry feed	Lot 3 Wheat pasture and mineral	Lot 4 Wheat pasture only	Lot 5 Wheat pasture only
1/29/41 Initial wt.	309	309	308	306	308
2/19/41	336	—	—	—	328
2/26/41	—	340	327	330	—
3/ 3/41	350	348	340	339	334
3/19/41	380	—	—	—	356
3/25/41	—	380	361	358	—
3/31/41	—	398	376	373	—
4/ 8/41	401	417	394	397	386
4/16/41	410	—	—	—	397
4/24/41	—	441	426	424	—
5/15/41	428	472	455	462	449
Gain per calf	119	163	147	156	141
Ave. daily gain	1.12	1.54	1.39	1.47	1.33

There was little difference between the rate of growth of the calves in lot 3 receiving bone meal, ground limestone and salt and those in lots 4 and 5 receiving no mineral supplement. Lot 2, receiving sumac cane fodder in addition to mineral and green wheat, made 0.15 pound better daily gain than lot 3, 0.07 pound more gain than lot 4 and 0.21 pound better gain than lot 5. It is interesting to note that the steers in lot 2 consumed only 475 pounds of cane fodder or 0.9 pound per head daily. Very little scouring was noted in lots 1 and 2, while lots 3, 4 and 5 on wheat pasture without dry feed exhibited diarrhea most of the time.

The steers in lot 2 consumed 5 pounds of bone meal, 4.3 pounds ground limestone, and 20 pounds salt. The calves in lot 3 consumed 5 pounds bone meal, 6 pounds ground limestone, and 13 pounds salt. The calves on wheat pasture ate principally bone meal the first six weeks. During the latter part of the trial, however, they consumed more ground limestone as the calcium-phosphorus ratio of the wheat became narrower.

The average results of the periodic analysis of the blood for serum phosphorus, calcium and magnesium for the five lots are given in table 2. These results are largely inconclusive. Wide individual variations indicate the

TABLE 2.—AVERAGE PERIODIC PHOSPHORUS, CALCIUM AND MAGNESIUM CONTENT OF BLOOD SERUM OF HEREFORD CALVES[1]

Lot no.	Ration	Date	Serum		
			P mg. %	Ca mg. %	Mg mg. %
1	Dry lot	2/ 5/41	8.52	10.24	3.11
		2/19/41	8.69	9.57	2.57
		3/ 3/41	8.73	8.63	2.31
		3/19/41	9.07	8.50	2.48
		3/25/41	8.56	7.93	2.70
		4/16/41	8.31	7.28	2.85
		Average	8.65	8.69	2.67
2	Wheat pasture, mineral and dry feed	1/16/41	9.49	11.15	2.79
		1/30/41	9.23	10.11	2.96
		2/12/41	7.56	9.98	2.39
		2/26/41	7.74	8.63	2.47
		3/12/41	7.29	9.37	2.47
		3/25/41	7.91	7.64	2.47
		4/ 8/41	8.58	8.82	2.16
		4/24/41	9.91	10.09	2.76
		Average	8.46	9.47	2.56
3	Wheat pasture and mineral	1/16/41	9.16	11.00	2.81
		1/30/41	8.67	10.39	3.04
		2/12/41	7.25	10.41	2.41
		2/26/41	7.51	8.29	2.50
		3/12/41	7.71	8.91	2.44
		3/25/41	7.25	7.92	2.11
		4/ 8/41	8.59	8.70	2.12
		4/24/41	8.89	9.78	2.51
		Average	8.13	9.42	2.49
4	Wheat pasture only	1/16/41	9.39	11.21	2.64
		1/30/41	8.43	10.06	2.78
		2/12/41	—	10.33	2.32
		2/26/41	7.43	8.21	2.21
		3/12/41	—	8.42	2.03
		3/25/41	7.82	8.87	1.94
		4/ 8/41	7.80	8.60	1.88
		4/24/41	7.56	9.94	2.43
		Average	8.07	9.46	2.28
5	Wheat pasture only	2/ 5/41	8.71	9.89	3.19
		2/19/41	6.93	10.11	2.56
		3/ 3/41	8.97	8.55	2.39
		3/19/41	7.48	8.04	2.20
		3/25/41	7.93	7.70	2.30
		4/16/41	8.66	8.44	2.60
		Average	8.11	8.79	2.54

[1] The calves were put on wheat pasture January 29.

probable inadequacy of blood analyses for work of this kind. All lots grazing wheat showed the same general trends in blood chemistry. Blood serum phosphorus dropped sharply as soon as the animals were placed on wheat pasture and remained low until the latter part of the experiment. The serum phosphorus of the dry-lot heifers did not show a corresponding drop. This difference was not due to the sex factor because it is noted that lot 5 heifers on wheat pasture showed a rapid drop in serum phosphorus.

Serum calcium showed the same general downward trend in all five lots

TABLE 3.—PERIODIC ANALYSES[1] OF GREEN WHEAT PASTURE USED IN GRAZING EXPERIMENT

No. sample	Date[2]	Approximate height in.	Total moisture %	Protein %	Ash %	Calcium %	Phos. %	Magnesium %
211	11/ 5/40	2.0	74.4	22.9	15.2	0.33	0.27	0.30
215	11/15/40	3.0	62.1	22.4	13.3	0.33	0.30	0.28
220	12/ 2/40	3.5	69.4	20.2	10.0	0.29	0.24	0.30
221	1/ 1/41	3.5	66.3	20.6	11.8	0.30	0.28	0.20
226	1/16/41	4.0	69.4	21.1	18.9	0.36	0.32	0.20
229	1/30/41	4.0	66.2	24.0	14.0	0.33	0.32	0.20
232	2/15/41	3.5	63.0	19.3	14.0	0.35	0.30	0.20
238	3/ 3/41	3.0	69.4	21.7	16.0	0.38	0.36	0.20
244	3/29/41	2.5	74.5	26.7	13.2	0.32	0.38	0.20
245	4/ 2/41	2.0	73.8	26.4	13.5	0.30	0.38	0.20
246	4/ 9/41	2.0	76.2	26.7	14.8	0.30	0.35	0.22
248	4/16/41	1.5	74.0	23.3	14.7	0.29	0.35	0.23
Average			69.9	22.9	14.1	0.32	0.32	0.23

[1] All analyses except moisture are reported on dry-weight basis.
[2] The wheat was sown October 10, 1940.

which might have resulted from increasing age of the animals. All four wheat pasture lots averaged higher in serum calcium than the dry lot calves. Serum magnesium of animals in lot 2 was slightly higher than those in lots 3 and 4 which did not have dry feed with wheat pasture.

Table 3 shows the chemical composition of wheat pasture at different stages of growth. These analyses show wheat to be a good and fairly constant source of protein, phosphorus, calcium and magnesium, from the early stages of growth to the time when the heads begin to appear. All samples taken before March 29, 1941, had an average Ca:P ratio of about 1.1:1. After March 29 the ratio dropped to approximately 0.8:1. It is rather interesting to observe that serum phosphorus content of the blood of all animals grazing on wheat pasture began increasing after March 25.

Cases of Milk Fever and Grass-Tetany in Cows Grazing Wheat

During the wheat grazing season of 1940–41 six cases of so-called "wheat poisoning" were reported to the experiment station. Results of blood mineral analyses immediately before and 24 hours after treatment with calcium gluconate are shown in table 4. Sjollema (1932) reported that grass-tetany was characterized by an abnormally low serum magnesium in contrast to a

TABLE 4.—CHEMICAL ANALYSES OF BLOOD SERUM IN CASES OF MILK FEVER AND GRASS-TETANY BEFORE AND AFTER TREATMENT WITH CALCIUM GLUCONATE

Case no.	Sampling	Phos. mg.%	Ca mg.%	Mg mg.%	Ca/P	Mg/P	Ca/Mg	Ca+Mg/P
1	(1) before treatment[1]	12.7	4.2	3.4	0.33	0.27	1.24	0.60
	(2) 24 hrs. after	14.5	4.1	3.6	0.28	0.26	1.14	0.53
2	(1) before treatment	1.2	2.8	4.5	2.33	2.75	0.62	6.08
	(2) 24 hrs. after	2.2	4.4	4.6	2.00	2.09	0.96	4.09
3	(1) before treatment	4.0	3.7	3.9	0.93	0.98	0.95	1.90
	(2) 24 hrs. after	4.8	7.6	2.4	1.58	0.50	3.17	2.08
4	(1) before treatment	1.2	2.5	1.9	2.09	1.58	1.32	3.67
5	(1) before treatment	2.4	2.9	1.2	1.21	0.50	2.42	1.70
	(2) 36 hrs. after	2.8	4.5	0.9	1.61	0.32	5.00	1.93
6	(1) before treatment	7.8	4.6	2.2	0.59	0.28	2.09	0.87
	(2) 5 hrs. after first treatment	8.5	6.6	2.5	0.78	0.29	2.54	1.07
	(3) 24 hrs. after second treatment	10.0	8.1	2.3	0.81	0.23	3.52	1.04
	Average before treatment	4.9	3.5	2.9	0.71	0.59	1.21	1.31
	Average after treatment	7.1	5.9	2.7	0.83	0.38	2.18	1.21

[1] Treatment consisted of intravenous injection of 250 cc. calcium gluconate.

high serum magnesium in cases of milk fever. The serum magnesium values reported in this table indicate that all of the six cases reported were probably milk fever except case 5 which had a serum magnesium value of 1.2 mg. per cent before treatment and 0.9 mg. per cent thirty-six hours afterward.

The cases reported were all cows of beef or dual-purpose breeding, weighing 1100 to 1300 pounds. They had been on wheat from three to five months. Cases 1 and 5 had access to ground limestone and salt. Cases 2 and 4 had been fed some roughage and grain. All cows except case 1 had calves less than a month old. The case 1 cow was some six to eight months with calf.

Treatment for all six cows consisted of intravenous injection of 250 cc. of calcium gluconate. All animals responded successfully to treatment except case 1. This cow failed to respond to 750 cc. of calcium gluconate and dextrose solution.

The data in table 4 show that intravenous injection of calcium gluconate resulted in increasing both serum phosphorus and calcium except in the unsuccessful treatment of case 1. Serum magnesium was lowered or left essentially unchanged as the result of calcium gluconate treatment. A consideration of Ca:P, Mg:P, Ca:Mg and Ca plus Mg:P ratios failed to show any uniformity either before or after treatment with calcium gluconate. It is interesting to note that cases 3, 4 and 5 were still below normal in serum phosphorus and calcium, yet the animals fully recovered. This strongly suggests a nervous or glandular disturbance in grass-tetany and milk fever, and also suggests that the principal action of calcium gluconate may be stimulation. These results further support the statement by Sjollema (1932) that milk fever and grass-tetany are not results of simple mineral deficiencies but are much more complex, probably involving causes not yet fully understood.

Summary

In this study chemical analysis showed growing wheat to be an excellent source of calcium, phosphorus, magnesium and protein. Before March 25 the calcium-phosphorus ratio averaged 1.1:1 and after March 25, 0.8:1.

When the calcium-phosphorus ratio of the wheat was above 1:1 Hereford calves grazing wheat pasture chose principally bone meal. As the calcium-phosphorus ratio became lower than 1:1 they ate ground limestone almost exclusively. Calves receiving bone meal and ground limestone failed to make more gain than those on wheat pasture alone. Calves receiving dry forage in addition to wheat pasture and mineral supplement made slightly larger gains than those receiving no dry feed.

Analyses of blood for serum calcium, phosphorus, and magnesium failed to show any definite results that might be correlated with animal disorders resulting from grazing wheat. Blood phosphorus was lower for the calves on wheat pasture than for those in dry lot. Serum magnesium of animals receiving green wheat alone was lower than that of the animals receiving mineral and dry feed.

Blood analyses from six animals stricken with symptoms resembling milk fever or grass-tetany while grazing wheat pasture showed that serum calcium and phosphorus were low and serum magnesium high. As a result of treatment with calcium gluconate, serum calcium and phosphorus were increased while serum magnesium was generally lowered. Consideration of Ca:P, Mg:P, Ca:Mg and Ca plus Mg:P ratios in these cases failed to show

any uniformity either before or after treatment. This supports the belief that grass-tetany and milk fever may be complex nervous or glandular disturbances instead of simple mineral deficiencies.

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SEASONAL CHANGES IN THE LIGNIN AND CELLULOSE CONTENT OF SOME MONTANA GRASSES[1]

A. R. Patton and Leonard Gieseker[2]
Montana Agricultural Experiment Station

LIGNIN in forage plants is not only practically unavailable to the ruminant, but also has an adverse effect on the digestibility of other constituents as well. Hale, Duncan and Huffman (1940) found lignin varied in digestibility from −5.1 to 23.7 per cent, but none of the digestion took place in the rumen. According to Csonka, Phillips and Jones (1929), lignin digestion is the result of enzyme action in the stomach. Crampton (1940) stated that lignin probably serves no useful dietary function in the animal, since the small amounts absorbed are re-excreted in the urine.

The partition of the carbohydrates in forage plants into indigestible (lignin), partially digestible (cellulose), and easily digestible (other carbohydrates) fractions is superior to the old crude fiber nitrogen-free extract method, because it replaces an empirical procedure having very little biological significance with a method of greater usefulness in predicting the nutritive value of forage plants.

Norman (1939) stated that the failure to include lignin was the most serious criticism of the usual system of grass analysis. Guilbert and Goss (1941) found a decrease in the digestibility of nitrogen-free extract, crude fiber, cellulose, and other carbohydrates as lignin values increased. Crampton and Maynard (1938), Heller and Wall (1940) and others concurred in their approval of the lignin analysis for predicting feeding values of forage plants.

Lignin, as isolated from the woody portion of plants, is not a single compound but a group of similar organic substances. These contain methoxyl groups, aromatic nuclei, and a C/O ratio higher than that of true carbohydrates. For a review of the complex chemistry of lignin, reference is made to Phillips (1934). In spite of a vast amount of research, the constitution of lignin remains obscure and consequently the quantitative determination of lignin is still somewhat empirical. That this is but little deterrent to its practicality in feed analysis is evidenced by the results of actual feeding trials. Crampton and Maynard (1938) recovered 99.3 per cent of the ingested lignin in feeding trials with steers.

[1] Contribution from the Chemistry Department, Montana Agricultural Experiment Station, Bozeman, Montana. Approved by the Director for Publication as Paper No. 156, Journal Series.

[2] A major part of the data in this article was obtained from a thesis presented by Leonard Gieseker as partial fulfillment of the requirements for the degree of master of science.

Experimental

Grasses were collected from May to September, 1940, from two-acre plots maintained near Bozeman by the animal industry and agronomy departments of the Agricultural Experiment Station.[3] Samples were classified in growth stages as suggested by McCarty (1938):

A. Snow disappearance to flower stalks first in evidence.
B. Flower stalks first in evidence to heads fully out.
C. Heads fully out to flowers in bloom.
D. Flowers in bloom to seeds fully ripe.
E. Seed heads shattered.

Methods of collection followed as closely as possible the outline prepared by the Forest Service and the Bureaus of Animal Industry and Plant Industry, U. S. D. A. (1940). Standard chemical practice was employed in the preparation and analysis of samples. Lignin and cellulose were determined by the method of Crampton and Maynard (1938), and are reported on the dry basis in table 1.

Discussion

These grasses were grown under the same conditions of soil and climate. For comparison, samples of Fairway and Standard crested wheatgrass grown at another location, representing the dry-land area of central Montana,[4] were also analyzed. It is needless to present the data here, since the grasses at both locations showed essentially the same increases in lignin and cellulose. The only difference was that the dry-land grasses matured earlier and reached their highest lignin and cellulose levels about a month earlier. Gains in weight obtained in feeding trials with these dry-land crested wheatgrasses have already been published by Clark and Williams (1941). Since their figures are available, it is interesting to compare the gains they obtained with the lignin values obtained in the present work for the same grasses. When three groups of eight Hereford steer calves were fed a total of 120 days on crested wheatgrass cut at different stages of maturity as the sole source of roughage, the average daily gains per head were 1.52, 1.26, and 0.91 pounds in the three groups. The lignin values corresponding to these gains were found to be 9.4, 13.1 and 14.2 per cent, respectively. These data, although admittedly meager, tend to corroborate the findings of others that increased lignin content is associated with lowered rate of growth (Ellis, 1940).

[3] Fort Ellis Experimental Farm.

[4] Judith Basin Branch Station, Moccasin, Montana. The authors are indebted to Ralph Williams, superintendent, for sending these grass samples.

In addition to the lignin and cellulose analyses reported here, ash, ether extract, protein, other carbohydrates, and various minerals were determined in all the grasses.

Crude protein was found to decrease with season in a manner well-known

TABLE 1.—PER CENT LIGNIN AND CELLULOSE AT VARIOUS STAGES OF MATURITY

Type of grass	Date	Stage	Lignin	Cellulose
Standard Crested Wheatgrass Agropyron cristatum (L.) Gaertn.	5/16	A	5.3	20.2
	5/31	B	7.2	25.2
	6/12	C	8.9	27.6
	6/26	D	13.2	32.4
	9/ 4	E	15.6	40.4
Fairway Crested Wheatgrass Agropyron cristatum (L.) Gaertn.	5/16	A	5.7	22.5
	5/31	B	7.5	25.5
	6/12	C	9.3	27.9
	6/26	D	11.6	29.1
	9/ 4	E	14.1	36.9
Slender Wheatgrass Agropyron pauciflorum (Schwein) Hitch.	5/16	A	5.3	21.1
	5/31	A	6.7	24.8
	6/12	B	7.4	28.1
	6/26	C	10.2	31.6
	7/24	D	13.3	36.6
	9/ 4	E	14.0	39.7
Smooth Brome Grass Bromus inermis Leyss.	5/16	A	5.2	23.2
	5/31	B	6.0	27.2
	6/12	C	8.5	28.8
	6/26	D	11.2	31.1
	9/ 4	E	17.8	41.3
Mountain Brome Grass Bromus marginatus Nees.	5/16	A	5.1	21.6
	5/31	B	6.1	26.8
	6/12	C	9.1	28.6
	6/26	D	11.2	29.1
	9/ 4	E	13.3	38.5

from many analyses in the past. Much of the superior value of young green grass has formerly been ascribed to this higher protein content. It seems reasonable now to claim that some of the advantage may be due to the low lignin content and the resulting higher digestibility of young grass.

It is not intended that any final conclusions be attempted on the basis of lignin analyses until much more information is obtained. It is hoped, however, that with the amassing of sufficient data lignin analyses may prove to be a useful tool in predicting the digestibility and feeding value of forage

plants. During the 1940 season slender wheatgrass remained lower in lignin until later in the season than any of the other grasses. Fairway crested wheatgrass had a lower lignin value than Standard crested wheatgrass, indicating a qualitative superiority of the Fairway variety. Mountain brome proved superior to smooth brome, because the latter had a much higher lignin content.

The value of the cellulose determination in the scheme of feed analysis is an outcome of the digestibility of cellulose by the action of micro-organisms in the ruminant. Naumann (1940) found cotton to be 90 per cent digestible by sheep. Holtan and Holtan (1940) stated that cellulose in feedstuffs must have a low lignin content in order to be digestible. The digestibility of cellulose as determined in grasses would be considerably less than 90 per cent, because the cellulose is always associated with more or less lignin, and because the cellulose as determined is not as pure as cotton cellulose.

About one-third of the dry weight of the grasses was due to "other carbohydrates," a fraction obtained by difference and including hemicelluloses, starches, sugars, and other easily digested carbohydrates. The importance of this fraction as a source of warmth and energy for livestock on winter range in a cold climate has probably been underemphasized.

If lignin were merely an inert diluent of the feed, it would still be of importance because it is a major constituent. Lignin is not only practically indigestible itself; it also decreases the availability of the other constituents of forage crops. It seems likely that this may result from any of three conditions: (1) The lignin may incrust the other digestible constituents, putting them "in a nutshell which the animal can't crack," (2) lignin may combine chemically with other constituents, forming unavailable compounds, and (3) it seems possible that digestion may be retarded through local inhibition of digestive enzymes due to the toxic action of phenolic groups resulting from the partial decomposition of lignin.

Summary

Lignin and cellulose were determined in five species of grass, at five different stages, and in two localities in Montana. Lignin increased with advancing season, from about five per cent in May to eighteen per cent in September, with considerable species difference. Lignin content closely paralleled cellulose content. Grasses in a more arid region reached the maximum lignin values earlier in the season. Fairway crested wheatgrass contained less lignin than the standard variety, and slender wheatgrass contained less lignin than either. Mountain brome contained less lignin than smooth brome. Lignin is believed to be of definite value in predicting the feeding value of forage plants.

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PERFORMANCE OF EWES BRED FIRST AS LAMBS COMPARED WITH EWES BRED FIRST AS YEARLINGS

D. A. Spencer, R. G. Schott, R. W. Phillips, and B. Aune
U. S. Department of Agriculture[1]

THE usual practice among sheepmen is to breed their ewes for the first time at about 18 months of age, so the first lambs are produced at two years of age. Since many ewe lambs born in the early spring come in estrus the following fall, it is possible that lifetime production may be increased by breeding at this time. The present work was undertaken to determine the effect of breeding first as lambs, as compared with breeding first as yearlings, upon the performance of the ewes.

Materials and Methods

Data were collected on Hampshire ewes born during an 8-year period, 1929 to 1936 inclusive. Performance was followed for 5 years on all ewes that survived, so the last data were collected in 1941 on ewes born in 1936.

One hundred nineteen pairs were studied. The number of pairs selected for use exceeded this number, but only those of which both members survived until after shearing as yearlings were included in the analysis. The numbers of pairs available for study that started on experiment in the different years from 1929 through 1936 were 8, 11, 13, 15, 16, 16, 20, and 20, respectively.

The animals in each pair were selected for similarity in age, weight, type, and ancestry.

The breeding season for ewes being bred first as lambs began near the end of December when they were 9 to 10 months of age. For ewes being bred first, as yearlings, the breeding season began near the end of September at the age of 18 or 19 months. The breeding season on both groups at later ages began near the end of September. Pen mating was practiced. Rams remained with the ewes approximately 5 to 6 weeks.

The flock was handled under farm flock conditions at the Belle Fourche Field Station at Newell, South Dakota. To insure thrift and normal development the sheep and lambs of this flock were at all times provided with plenty of good feed either in pastures or at the barn. They were occasionally

[1] The U. S. Bureaus of Animal Industry and Plant Industry, and the South Dakota Agricultural Experiment Station cooperated in obtaining the results herein reported.

pastured on native range forage but as much of this farm was cultivated and many of the fields were irrigated, alfalfa constituted a large share of their pasture. Sweet clover and mixed grass pastures of brome grass, orchard grass and the fescues were usually fitted into the rotation so that good pasture was available throughout the spring, summer, and fall of the normal years. Alfalfa hay was the primary feed afforded the flocks during the winter. Grain consisting chiefly of corn, oats, and barley was fed in seasons of need for such feed. The rams were also fed grain when pastures were sparse and especially during the breeding season.

The sheep were drenched with copper sulphate and nicotine sulphate in late June or during the month of July and when advisable they were again drenched in August. They were also rotated on the pastures to keep the forage relatively fresh, especially for the lambs.

The flocks were well sheltered in times of cold and in wet storms but all the sheep and lambs were given opportunity for normal daily exercise. Each year the ewes that were bred when they were about 18 months old lambed chiefly during the season extending from late February to the latter part of March, and the ewes bred as lambs gave birth to their first offspring during the period extending from early May to mid-June. All sheep of shearing age in this flock were, as a rule, sheared during the last half of May in each year.

Data and Discussion

One hundred nineteen ewes were exposed to breeding as lambs. Of this number 84 actually produced lambs. Thus, 35 ewe lambs, or 29.4 per cent of the group, did not conceive. Analysis of the data by years indicates that the proportion of ewe lambs which failed to conceive is consistent from year to year. Since this group automatically divided itself on the above basis, it became necessary to consider the data in four categories. Of the ewe lambs exposed to breeding, those that lambed were designated as group A and those that failed to lamb as group B. The pair mates of these two groups were designated as groups C and D, respectively. Briggs (1936) reports that 18 of 122 crossbred Hampshire-Rambouillet ewe lambs exposed to breeding failed to conceive.

The average ages of the groups at pairing are shown in table 1, and these are practically identical for all groups.

Group B had a lower average body weight than group A. The figures are given in table 1, and the difference was 5.6 pounds. This was statistically significant ($p = .05$). Thus, it appears that the ewes which were able to conceive as lambs tended to be the larger individuals. Since one of the considerations in pairing was body weight, it is obvious that groups C and D should

show similar weight differences, and the average weight in group C was 5.2 pounds greater than in group D. It may be significant that there was more variability in group B than in group A, as is indicated by the standard errors shown in table 1. This difference persists throughout the 5 years the animals were observed. This same difference naturally occurs in groups C and D, containing pair mates of groups A and B, respectively.

Another point which was considered in pairing was type. All animals were scored on type, a score of 1 being the nearest to ideal. Five scores were used. The average scores in the four groups were all practically identical, being 1.75, 1.74, 1.70, and 1.71, respectively. The individuals used were selected from those retained for replacements in the breeding flock.

TABLE 1.—AVERAGE WEIGHTS OF EWES, AND AGES AT PAIRING

Year	Stage	Bred as lambs				Bred as yearlings			
		Group A (Lambed first year)		Group B (Dry first year)		Group C (Pair mates of ewes lambing first year)		Group D (Pair mates of ewes dry first year)	
		No.	*Age, days*	*No.*	*Age, days*	*No.*	*Age, days*	*No.*	*Age, days*
1	Pairing	84	271.7±1.8*	35	271.0±3.7	84	270.7±2.0	35	270.2±3.4
			Weight, lbs.		*Weight, lbs.*		*Weight, lbs.*		*Weight, lbs.*
	Pairing	84	102.8±1.8	35	97.2±2.9	84	101.2±1.4	35	96.0±2.1
2	Mating	82	120.7±2.4	33	134.8±3.4	80	138.9±1.9	35	136.2±2.2
3	Mating	71	141.4±2.3	24	150.3±5.1	67	144.4±2.5	27	141.4±3.3
4	Mating	49	155.0±2.9	23	153.3±6.2	46	154.5±2.8	19	157.1±4.6
5	Mating	36	156.8±2.5	9	165.9±8.4	31	163.0±4.3	12	162.7±7.8

* Standard error of the mean.

The numbers of animals present and their average weights at mating are shown in table 1. All groups were subject to the usual culling in which individuals that showed marked deficiencies in conformation and wool yield were discarded. Some death losses also occurred. It is evident from the figures in table 1, and also from those given in tables 2 and 4, that the decrease in numbers from these causes was at approximately the same rate in each group.

The ewes which became pregnant as lambs (group A) were lighter than the other three groups at mating time in the second year, or when they were 18 to 19 months of age. The average difference between animals in group A and their pair mates in group C was 18.2 pounds. This difference was highly significant. There were no significant differences in body weight between groups at mating in the third, fourth, and fifth years. Thus, it appears that

animals in group A had overcome the weight disadvantage which resulted from their being bred as lambs by the time they were approximately 2½ years of age, or at mating time in the third year. These results are in agreement with those reported by Bowstead (1930) and Briggs (1936). They also agree with results in Germany that were summarized by Burns (1934).

TABLE 2.—REPRODUCTION OF EWES

Year	Items compared	Bred as lambs		Bred as yearlings	
		Group A	Group B	Group C	Group D
1	Ewes dry (No.)	0	35	84	35
	Ewes lambing (No.)	84	—	—	—
	Lambs born (No.)	89	—	—	—
	Birth weight (lbs.)	8.6±0.2*	—	—	—
2	Ewes bred (No.)	82	33	80	35
	Ewes dry (No.)	8	4	3	3
	Ewes lambing (No.)	70	25	74	29
	Lambs born (No.)	110	43	144	51
	Birth weight (lbs.)	8.9±0.2	8.8±0.3	8.4±0.1	8.6±0.3
3	Ewes bred (No.)	71	24	67	27
	Ewes dry (No.)	4	3	1	2
	Ewes lambing (No.)	54	20	54	20
	Lambs born (No.)	95	43	109	37
	Birth weight (lbs.)	9.9±0.3	8.6±0.3	9.2±0.2	9.7±0.2
4	Ewes bred (No.)	49	23	46	19
	Ewes dry (No.)	0	1	5	0
	Ewes lambing (No.)	46	16	36	18
	Lambs born (No.)	81	34	63	32
	Birth weight (lbs.)	9.8±0.2	9.2±0.3	9.9±0.1	9.7±0.4
5	Ewes bred (No.)	36	9	31	12
	Ewes dry (No.)	4	0	2	0
	Ewes lambing (No.)	26	9	26	9
	Lambs born (No.)	52	15	54	20
	Birth weight (lbs.)	9.2±0.3	10.3±0.5	9.0±0.3	9.3±0.4

* Standard error of the mean.

The level of reproduction in the four groups is summarized in table 2. The 84 ewes in group A produced a total of 89 lambs in their first year. In the four subsequent years the total numbers of ewes exposed to breeding in the four seasons in groups A to D were 212, 78, 201, and 81, respectively. Thus the total numbers of breedings in groups A and C were approximately equal, and the same is true of groups B and D. From these numbers, totals of 196, 70, 190, and 76 ewes lambed while totals of 16, 8, 11, and 5 were dry.

The proportion of ewes lambing was essentially the same in all groups. When tested for proportionate differences by the X^2 test they were shown to be homogenous. The same applies, of course. to the numbers of dry ewes. The total numbers of lambs produced by the four groups in the four years were 338, 135, 370, and 140. The difference between groups A and C was 32 lambs, and between B and D, 5 lambs. These differences were not statistically significant. When the first crop of lambs is considered, group A produced a

TABLE 3.—NUMBERS AND WEIGHTS OF LAMBS WEANED

Year	Item compared	Bred as lambs		Bred as yearlings	
		Group A	Group B	Group C	Group D
1	Lambs weaned (No.)	60	—	—	—
	Average weight (lbs.)	54.3±1.2*	—	—	—
2	Lambs weaned (No.)	73	30	102	39
	Average weight (lbs.)	71.0±1.4	68.7±3.2	67.8±1.5	69.3±2.3
3	Lambs weaned (No.)	67	30	73	28
	Average weight (lbs.)	72.1±2.1	68.1±2.5	70.4±2.2	69.3±2.9
4	Lambs weaned (No.)	73	20	47	23
	Average weight (lbs.)	66.9±2.1	65.5±5.1	77.8±1.8	70.4±2.5
5	Lambs weaned (No.)	32	12	33	12
	Average weight (lbs.)	71.6±2.8	71.0±4.3	65.3±2.2	64.7±5.0
Totals	Lambs weaned (No.)	305	92	255	102
	Average weight (lbs.)	67.0±0.9	68.2±1.0	70.1±1.0	69.0±1.4
	Total weight of lambs weaned (lbs.)	20,442	6,274	17,870	7,039

* Standard error of the mean.

total of 427 lambs in five years, compared with 370 by group C in four years, or a difference of 57 in favor of group A.

The lambs weaned and the average weaning weights in each group are shown in table 3. The total numbers of lambs weaned in the four groups were 305, 92, 255, and 102. The most important comparison, of course, is between groups A and C. Group A produced a total of 50 more lambs at weaning than group C. In terms of pounds of lamb available for marketing this is a difference of 2,572 pounds.

One of the interesting points in the data dealing with reproduction and lamb production in groups A and C, is that group C produced more multiple births than group A in the second and third years. On the basis of the X^2

test the differences were not sufficiently large to be significant, but they were reflected in somewhat lighter average birth and weaning weights in group C.

The results dealing with lamb production are similar to those reported by Briggs (1936), who found that over a 6-year period the early-bred ewes about maintained the advantage secured the first year by being bred as lambs. They also agree with those summarized by Burns (1934), who reports no appreciable decrease in size due to early breeding. However, they do not agree with findings of Bowstead (1930), who reports that lamb-bred ewes produce more lambs and heavier and thriftier lambs at 2 and 3 years of age than do yearling-bred ewes at these same ages.

TABLE 4.—AVERAGE WEIGHTS OF FLEECES PRODUCED

Year	Bred as lambs				Bred as yearlings			
	Group A		Group B		Group C		Group D	
	No.	*pounds*	*No.*	*pounds*	*No.*	*pounds*	*No.*	*pounds*
1	84	8.2±0.2*	35	8.0±0.4	84	8.3±0.1	35	8.0±0.3
2	74	7.8±0.2	28	8.4±0.3	75	8.2±0.2	30	8.2±0.3
3	57	8.0±0.2	23	8.4±0.3	54	8.1±0.2	21	8.0±0.3
4	45	7.5±0.2	15	8.5±0.3	41	8.2±0.3	18	8.0±0.4
5	28	7.8±0.1	9	8.1±0.3	29	7.9±0.3	7	8.0±0.7
Totals and averages	288	7.9±0.1	110	8.3±0.2	283	8.2±0.1	111	8.0±0.2

* Standard error of mean.

The fleece production of the four groups, as measured by grease weight, is summarized in table 4. The average weights of fleeces produced by groups A and C were 7.9 and 8.2 pounds, respectively. The difference between these two groups was significant. Groups B and D were not significantly different. A comparison of the fleeces from group A with all those from groups, B, C, and D showed that the fleeces from group A were significantly lighter. The difference in wool production between group A and the other groups was relatively small, but it was statistically significant because of the small amount of variability within the groups. These results differ from those of Briggs (1936), who found no effect of early breeding upon wool production.

The practice of breeding ewes first as lambs might develop into one index of selection, in that the ewe lambs which conceive appear to be the more fully developed, on the average, as measured by body size. The fact that they conceive indicates earlier sexual maturity, and this may possibly be an indication of a generally higher level of fertility.

Summary and Conclusions

Data were collected on Hampshire ewes born during an 8-year period. One hundred nineteen pairs were studied. Pairing was based on age, weight, and family relationship. One of each pair was bred first as a lamb at the age of 9 or 10 months and the other first as a yearling at the age of 18 or 19 months. Eighty-four of the 119 exposed to breeding as lambs actually conceived. This group of 84 was designated group A and the 35 that failed to conceive as lambs were designated as group B. Their pair mates were classified as groups C and D, respectively. Performance was followed for 5 years.

Conception as lambs resulted in lighter weight of ewes at 2 years of age, but this deficiency was overcome by the third year.

Group A produced 89 lambs at 14 to 16 months of age. Total lambs born in groups A, B, C, and D were 427, 135, 370, and 140, respectively, and the totals reared to weaning were 305, 92, 255, and 102.

Average weaning weights of lambs in the 4 groups were 67.0, 68.2, 70.1, and 69.0 pounds, respectively. The average weaning weight of lambs from group A in the first year was 54.3 pounds, the lightest of any group of lambs. Group A produced a total of 2,572 pounds more lambs at weaning than group C.

Average annual fleece weights of the ewes in the groups were 7.9, 8.3, 8.2, and 8.0 pounds, respectively.

Under the conditions of this experiment, breeding ewes for the first time as lambs resulted in a material increase in total lamb production, with only a slight decrease in wool production. This practice is recommended under conditions where adequate development of ewe lambs is obtained.

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A CLIPPER FOR OBTAINING WOOL DENSITY SAMPLES

JOHN I. HARDY[1]
U. S. Department of Agriculture

IN ORDER that wool growers may select fleeces with greatest density to improve their flocks, an accurate method for securing small density samples rapidly has been urgently needed. Density methods requiring the use of various forms of calipers are described by Wildman (1936), Burns (1931), and Nordby (1928). These procedures are so time-consuming that they have been limited in their application. Hardy (1934) developed a shearing technique to measure wool density in which an area is sheared and measured and the wool removed for density measurements. It has proved satisfactory for wool scouring samples, but requires too large a sample to evaluate directly the number of fibers per unit area. This method as pointed out by Madsen, *et al.* (1941), furnishes such a large sample, that some of the variabilities in density are masked.

A new principle has been incorporated in the new density clipper device described in this paper.

The New Density Clipper

The idea was conceived of defining the area from which a density sample was to be taken by accurately shearing off the surrounding fibers. This was accomplished by having a cutter take the place of each jaw of a caliper, thereby removing two parallel swaths at one stroke of the clipper.

The clipper (see figure 1) is of the direct motor driven type which permits close control of the adjustments as well as positive action of the cutter. The first attempt at using two clippers bridged together showed that positive action was necessary and especially so on dense fleeces. The new device has narrow cutters so that curved portions of the body may be sampled. The cutter and comb have been elongated and provided with an accurately milled slot one centimeter wide. Positive contact of comb and cutter along this extended moving part is obtained by a tilting pressure plate, the tension of which is adjusted by a large knurled tension screw. This slot of comb and cutter gives ample clearance for the uncut wool.

Sampling Procedure

Samples may be taken with equal facility from the sheep in a standing or reclining position. Since the side is frequently sampled, it is convenient to

[1] Senior Animal Husbandman, Animal Fiber Investigations, Beltsville, Md.

lay the sheep on a table. It is a good policy to have a clear idea of the exact positions to be sampled and to have a definite routine to follow when large numbers are involved. The fleece is parted at the point where the sample is to be taken. The clipper is inserted and moved slowly for a distance of 2

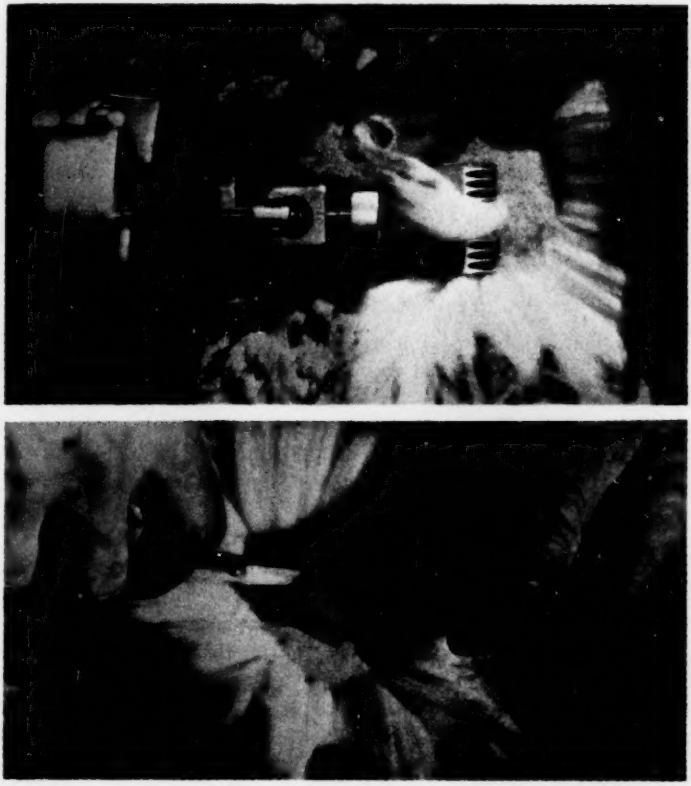

Figure 1. Top. Clipper for obtaining wool density samples. Bottom. Removing the sample.

inches across the skin. The cut wool from both parallel swaths is removed and the uncut wool is held with one hand while the clipper is again inserted. This second shearing is carried out at right angles to the first two swaths. The distance of travel of clipper should be just sufficient to connect the cut swaths. After the sheared wool is removed, a sample is left standing on a

square centimeter of skin area. In order to maintain the fibers in perfect alignment for subsequent measurements, they are bound together with a short piece of stout thread before cutting them off. An alternative procedure is to clamp the bundle with a haemostat and then seal the ends with a wax or plastic solution after they have been cut off.

By making the first swaths 3½ inches long and carefully controlling the cross-swaths, it is possible to obtain three adjacent samples. It has not been found practical to make longer swaths than this because of crowding of the wool. Too much force exerted on the clipper will result in placing the skin in an abnormal position as well as in actually cutting the skin. The sheep should be in a relaxed condition and in as normal a position as possible while sampling because straining or struggling of the animal while samples are being taken will produce unsatisfactory results irrespective of the instrument used for sampling. In general, the same precautions required in density sampling with other instruments are necessary.

Tests Made on the Clipper

A long piled rug having a uniform distribution of pile yarns was sampled with the clippers to ascertain the uniformity of such samples. A rug was chosen because it offers a larger area of rather uniform density than found on the average sheep. Twenty-five samples were removed and the end of each was sealed in paraffin wax. The sizes of the samples were ascertained by making cross-sectional area measurements under controlled conditions.

Results and Discussion

The samples from the areas 1 cm. sq. from the rug fabric were tested for cross-sectional area, using the method developed by Hardy and Wolf,[2] in a cross-sectioning device with a slot 45 thousandths inch wide at a pressure of 10 pounds. The smallest sample gave a relative thickness of 217, and the largest gave a reading of 262 thousandths of an inch. The mean size was 244.56 with a standard deviation of 12.12 thousandths of an inch. The standard error of the mean was 2.42. Since the rug was mechanically made we may assume a high degree of uniformity of fiber distribution and size of fibers. Assuming that, the above figures give an estimate of the accuracy with which the clipper can be used under the conditions of the test. Any error in the estimate of accuracy will be on the conservative side since variability within the rug would tend to increase the standard deviation and standard error of the mean.

The density clipper has many advantages over caliper devices that have

[2] Hardy, John I. and Harold W. Wolf. 1942. Wool density Samples Rapidly Measured by Cross-Sectional Area Determinations. In press as U.S.D.A. Circular.

been used in the past. Samples are taken with greater speed. Elaborate techniques are not needed. Areas are demarcated with greater precision, extraneous wool fibers are eliminated, and consecutive adjacent samples may be taken. The net result is greater accuracy with more precise knowledge of fleeces due to this accuracy, and possibilities of more thorough sampling. Samples can be taken in close proximity to each other. Such samples are usually difficult to obtain with a caliper since considerable wool may be pulled out during insertion of that kind of an instrument. Dense and felted fleeces may be sampled which could not be sampled with calipers.

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A STUDY OF THE VALUE OF INCUBATED EGGS AND METHODS OF FEEDING THEM TO GROWING AND FATTENING PIGS

J. P. Willman, C. M. McCay, O. N. Salmon and J. L. Krider
Cornell University

FOR many years it has been known that raw egg white is poorly digested by such omnivorous species as dogs, rats and man. When considerable amounts of raw egg albumin are eaten by these species, severe diarrhea develops. In the white rat, the feeding of high levels of raw egg albumin not only leads to severe diarrhea, but skin lesions ultimately develop. These have been extensively studied by Boas (1927), Parsons and Lease (1934), Salmon and Goodman (1934), György (1939) and others.

Formerly these skin lesions in rats were ascribed to some toxic property of the uncooked egg white. In recent years this skin trouble has been found to be due to a deficiency in the vitamin, biotin, which was first isolated from egg yolk by the Dutch scientists, Kögl and Tönnis (1936). Furthermore György, *et al.* (1940), du Vigneaud and co-workers (1940) have found that raw egg white creates this vitamin deficiency due to its peculiar property of seizing the supplies of this vitamin that may occur in the intestine and sweeping them from the body in the feces. Egg white itself contains biotin, but it never becomes available to the body if the egg white is eaten raw and not digested.

Limited experiments have been made at Cornell in feeding swine incubated raw chicken eggs obtained from a local hatchery. During a trial begun in January, 1940, with fifty-pound pigs and continued until the lot had a final average weight of 200 pounds, the average daily ration amounted to 2.7 pounds of ground yellow corn and 4.9 pounds of incubated eggs. The pigs were healthy in appearance and were always eager to eat the eggs. The question arises as to why swine fail to develop severe diarrheas on such a diet, since Bateman (1916) found the dog was affected if fed more than two raw eggs per day.

In the first trial the lot of 10 pigs fed the ration of ground yellow corn, salt and eggs gained at the rate of 1.2 pounds daily, as compared to 1.4 for a similar group fed a ration of ground yellow corn, meat scraps, linseed meal, ground alfalfa hay and salt. When one does not consider the difference in rate of gain, 100 pounds of eggs in this trial had a replacement value of 14.4 pounds of ground yellow corn, 12.0 pounds of meat scraps, and 4.6 pounds each of linseed meal and ground alfalfa hay.

Furthermore a question arose concerning the possibility of improving the utilization of incubated eggs by swine if the eggs were cooked. To determine the relative digestibility of raw and cooked incubator eggs by swine, digestion experiments were run.

Two litter-mate, fall-farrowed pigs which weighed 64.5 and 61.0 pounds, respectively, at the beginning of the first collection period were used. Each of the three collection periods were of six days duration and each was preceded by a preliminary feeding period of at least four days.

In each trial the pigs were fed equal weights of incubated eggs and ground yellow corn. Salt was mixed with the corn at the rate of 0.3 pound to each 100 pounds of corn. The eggs used in these trials were those that failed to

TABLE 1.—DIGESTIBILITY OF A RATION OF GROUND CORN AND RAW VS. COOKED INCUBATED EGGS

	Pig no.	Incubator-run eggs (with shells)		Infertile eggs (without shells)	
		Raw	Cooked	Raw	Cooked
Per cent of protein digested	34	—	88.9	88.7	91.6
	35	89.4	—	91.2	88.6
Per cent of fat digested	34	—	86.3	90.4	88.7
	35	86.4	—	89.5	87.8

hatch after 21 days of incubation. In the first collection period the eggs included the incubator-run of infertile eggs and those that contained partially developed chicks. Only the infertile eggs were used during the second and third collection periods. The pigs continued to have good appetites and each gained at the rate of about 0.9 pound daily from January 14 until the third collection period was concluded on February 10, 1941. The results of the digestion trials are shown in table 1.

Conclusions

There are two possible explanations for the results obtained in this study. The first is that swine are unique in their ability to digest raw egg albumin and may possess an enzyme system for this purpose that is superior to that of the rat, the dog and man. The second is that the holding of eggs at the temperature of the incubator so modifies the albumin that it is subject to digestion and therefore no longer seizes or holds biotin so that it is unavailable to the body. Furthermore, this suggests that biotin may be a key substance in the hatching of eggs. These possibilities are being studied further.

The results of these digestion trials indicate definitely that the fat and the protein were as efficiently digested in the raw eggs as in cooked eggs. Eighty-nine per cent of the protein and 86 per cent of the fat in the ration of corn and eggs (incubator run) were digested in the ration containing either raw or cooked eggs. In the same trials in which rations of corn and raw or cooked infertile eggs (without shells) were fed essentially the same digestion coefficients were obtained.

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THE EFFECT OF SEX ON THE DEVELOPMENT OF THE PIG. I. DIFFERENCES IN GROWTH BETWEEN BOARS AND BARROWS BY LINES OF BREEDING[1]

L. M. Winters, R. E. Comstock, D. F. Jordan, and O. M. Kiser
University of Minnesota

THE studies reported in the series of papers to appear under the main title given above arose from two separate observations. The first of these was the remark often overheard, "I castrated the wrong pig." This remark results from the observation that the barrows often develop into more attractive animals than their brothers which were left as boars. The second observation was that the inbred lines being developed in the Minnesota swine breeding project differed in development in response to the presence and absence of testes.

The Minnesota swine breeding project is in cooperation with the Regional Swine Breeding Laboratory. The main objective of the Minnesota project is to develop inbred lines which possess as much productivity as possible. Seven Poland China lines and one line from a crossbred foundation (Landrace-Tamworth) are in the process of development.

The object of the study reported herein was to determine the differences in growth between boars and barrows and to determine if the various inbred lines differed in their response to the presence and absence of testes.

Material and Methods

Six Poland China lines and one line originating from a crossbred foundation (henceforth known as Minn. No. 1) were drawn on. The lines were distributed between four different stations; hence measurements were taken by four different men, each working entirely independently of the others. The study was carried on during two years (1939 and 1940).

Boar-barrow pairs were made up when the pigs were eight weeks old. The members of each pair were litter mates. The experiment as planned called for the pairing of males as similar in weight as possible and no favoritism in weight was to be shown either barrows or boars.

The weights and measurements were first taken when the pigs were eight weeks old and repeated every four weeks until they reached a weight of 220 pounds or became 24 weeks old. The measurements taken were: I, length

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(from a point between the ears to tail head); II, heart girth; III, flank girth; IV, depth back of shoulders; V, width back of shoulders; VI, width of loin; and VII, height at shoulders.

Owing to a misunderstanding of directions, only a few Minn. No. 1 hogs were measured for shoulder height; hence no data on height of the Minn. No. 1 hogs are included in the tables. During the two years, 86 pairs were measured and of these, 67 pairs were Poland China and 19 were Minn. No. 1 hogs.

Observations and Discussion

Since the six Poland China lines showed no significant differences in their response to sex, the Poland China pairs are grouped and contrasted with the Minn. No. 1 pairs.

Weight data for the two groups are presented in table 1.

TABLE 1.—INCREASE IN WEIGHT BY AGE AND GROUPS

Age, weeks	8	12	16	20	24
Poland China					
Mean wt., lb., of barrows	32.98	60.73	100.42	146.31	194.90
Mean wt., lb., of boars	33.94	63.06	103.61	149.57	198.52
Difference, lb. (barrow-boar)	−.96*	−2.33†	−3.19*	−3.26	−3.62
Minn. No. 1					
Mean wt., lb., of barrows	34.05	65.37	114.00	169.11	202.53
Mean wt., lb., of boars	36.21	72.89	116.74	158.37	181.13
Difference, lb. (barrow-boar)	−2.16*	−7.52†§	−2.74	10.74*§	21.40†§

In this and all subsequent tables the symbols have the following meanings:

*the difference between the boars and barrows is significant at the 5 per cent level.

† the difference between the boars and barrows is significant at the 1 per cent level.

‡ the difference indicated is significantly larger ($P \leqq .05$) than the corresponding difference for the other breed.

§ the difference indicated is significantly larger ($P \leqq .01$) than the corresponding difference for the other breed.

In both groups the boars were significantly heavier than their barrow brothers at the time of pairing. This apparently is due to the unconscious reluctance to castrate the heavier and perhaps more attractive pigs. Fortunately, this initial advantage appears to have had no particular effect on the results of the experiment. At 12 weeks the boars of both groups were significantly heavier at the 1 per cent level with the Minn. No. 1 boars showing a significantly greater advantage over their brothers than the Poland Chinas.

This increased growth of the boars apparently is due to a growth stimulus received from the testes. Tang (1941) in a carefully controlled experiment with rats found that castrated male rats were significantly lighter than their controls. Tang's findings are in accord with those of Evans and Simpson (1927), van Wagenen (1928), Korenchevsky (1930), and Lawless (1936).

When 16 weeks old, however, the difference in weight between the boars and barrows of the Minn. No. 1 line was no longer significant and that of the Poland Chinas was significant at the lower level ($P \leqq .05$). At 20 weeks the difference between the Poland China boars and barrows was no longer significant even at the 5 per cent level. In the case of the Minn. No. 1 hogs the situation was reversed, and at 20 weeks the barrows were heavier at the 5 per cent level and at 24 weeks they were heavier at the 1 per cent level.

The data in table 1 indicate that the possession of testes stimulates weight increase but that the significance of this increase declines with advance in age. With advancing age, other factors apparently come into play which tend to offset the growth stimulus received from the testes. One of these other factors undoubtedly is sex drive for the Minn. No. 1 boars manifest considerable sex interest when from 16 to 20 weeks old. It is doubtful, however, if sex drive is the sole explanation because as will be seen in the subsequent tables, there are actual dimensional differences even after adjustments have been made for weight differences.

Measurements at 16 Weeks

Since no true sex differences were found at 8 and 12 weeks those data are omitted. At 16 weeks the boars and barrows of the Minn. No. 1 line showed a difference significant at the 5 per cent level for width of loin, and there was also a significant difference, at the 5 per cent level, between the breeds as to this measurement's response to castration (table 2). The difference is probably one of fat, for some of the Minn. No. 1 boars rant as early as 16 weeks.

The regression coefficients in table 2 and the subsequent tables are the increase of each measurement with each additional pound in weight. The corrected differences of this and the subsequent tables are those that exist after boar and barrow weights have been equalized by use of regression coefficients.

Measurements at 20 weeks

The measurements and differences at 20 weeks are presented in Table 3.

At 20 weeks the boar-barrow pairs of both groups show significant differences in heart girth, flank girth, width back of shoulders, and width at the loin. The Poland China boars were significantly taller than their barrow brothers and the Minn. No. 1 boars were significantly longer and the bar-

TABLE 2.—MEASUREMENTS IN INCHES AT 16 WEEKS

Measurement	I	II	III	IV	V	VI	VII
			Poland China				
Mean barrows	32.448	31.346	32.454	11.046	7.678	7.136	19.987
Mean boars	32.701	31.558	32.576	11.149	7.727	7.175	20.238
Difference (barrow-boar)	−.253	−.212	−.122	−.103	−.049	−.039	−.251
Regression coefficient	.0989	.1121	.1358	.0387	.0286	.0328	.0415
Corrected difference	.062	.146	.311	.020	.042	.066	−.119
			Minn. No. 1				
Mean barrows	34.711	33.653	34.174	11.174	8.542	6.953	
Mean boars	35.342	33.837	34.195	11.311	8.458	6.726	
Difference (barrow-boar)	−.631	−.184	−.021	−.137	.084	.227	
Regression coefficient	.0995	.0890	.0589	.0315	.0178	.0289	
Corrected difference	−.358	.060	.214	−.051	.133	.306*‡	

rows were significantly deeper. In all of the measurements excepting flank girth the two groups differed significantly with the Minn. No. 1 group showing the greater response to sex.

Measurements at 24 weeks.

In the original design of this experiment it was planned to continue meas-

TABLE 3.—MEASUREMENTS IN INCHES AT 20 WEEKS

Measurement	I	II	III	IV	V	VI	VII
			Poland China				
Mean barrows	36.809	36.181	37.601	12.742	8.785	8.218	22.730
Mean boars	36.951	36.167	37.072	12.848	8.758	8.070	23.170
Difference (barrow-boar)	−.142	.014	.529	−.106	.027	.148	−.440
Regression coefficient	.0588	.0835	.0981	.0267	.0214	.0231	.0352
Corrected difference	.050	.286†	.849†	−.019	.097*	.223†	−.325†
			Minn. No. 1				
Mean barrows	39.232	40.289	40.637	13.195	10.016	8.447	
Mean boars	39.221	37.853	38.311	12.500	9.405	7.679	
Difference (barrow-boar)	.011	2.436	2.326	.695	.611	.768	
Regression coefficient	.0482	.0751	.0921	.0228	.0120	.0181	
Corrected difference	−.507*§	1.629†§	1.337†	.450†§	.482†§	.574†§	

urements until one member of a pair reached 220 pounds or until the members became 24 weeks old. The weight limitation removed four Minn. No. 1 pairs from being included in the 24 week measurements, which thereby reduced the pairs in this group to 15. This likely had some effect on the significance of differences for this group although the mean corrected difference for length, heart girth, flank girth, and depth back of the shoulders is less for this group at 24 weeks then for the same group at 20 weeks, which indicates at least that lack of numbers was not the sole cause of the lack of significance in these measurements. In width back of the shoulders and width of loin the differences between boars and barrows for this group had increased.

In the Poland China pairs all corrected differences, excepting height at shoulders, were greater at 24 weeks than at 20 weeks, and of these differences only length was in favor of the boars. It is interesting and perhaps of some significance that length has shifted from an advantage for the barrows at 20 weeks to an advantage for the boars at 24 weeks. In the case of the Minn. No. 1 hogs the boars possessed an advantage (not significant, however) in length as early as 16 weeks.

General Discussion

The foregoing data make it perfectly clear that boars and barrows do differ in the way they grow. Furthermore, it is clear that there is a sexual difference between the Poland China and Minn. No. 1 hogs. The latter not only show greater differences between boars and barrows in the measurements taken but these differences appear at a younger age.

TABLE 4.—MEASUREMENTS IN INCHES AT 24 WEEKS

Measurement	I	II	III	IV	V	VI	VII
			Poland China				
Mean barrows	39.987	40.416	41.876	14.190	9.837	9.196	24.792
Mean boars	40.300	40.193	41.037	14.236	9.678	8.942	25.098
Difference (barrow-boar)	−.313	.223	.839	−.046	.159	.254	−.306
Regression coefficient	.0465	.0678	.0752	.0247	.0210	.0221	.0197
Corrected difference	−.145	.468†	1.111†	.043	.235†	.334†	−.235*
			Minn. No. 1				
Mean barrows	42.280	43.293	43.500	14.173	10.927	9.273	
Mean boars	41.360	39.827	39.720	13.267	9.987	8.140	
Difference (barrow-boar)	.920	3.466	3.780	.906	.940	1.133	
Regression coefficient	.0618	.1156	.1267	.0280	.0051	.0257	
Corrected difference	−.403	.992§	1.069†	.307‡	.831†§	.583†‡	

The measurements indicate that the differences in growth between boars and barrows is to be explained largely by differences in skeleton and deposit of fat, the former being in favor of the boars and the latter in favor of the barrows. This is in keeping with Tang's (1941) studies of rats. It is perhaps unfortunate that width measurements through the shoulders and at the hips were not also taken, for they would have given additional useful information on skeletal development.

Boars and barrows do appear different to the eye but the actual dimensional differences are for the most part quite small when the boars and barrows are put on an equal weight basis. At 24 weeks the Poland China boars were only .145 inch longer than the barrows. It is almost inconceivable that the eye would detect so small a deviation from a 40 inch hog. The difference likely is accentuated by the barrows' slightly greater depth (.043) back of the shoulders and increased heart and flank girth measurements. The corrected difference between Poland China boars and barrows for each dimension (length, depth back of shoulders, width back of shoulders, and height at shoulders) measured is quite small, so small as to lead one to suspect it is the accumulation of these small differences that strikes the eye.

Since sexual activity is a necessity in a herd boar, since the Minn. No. 1 boars show sexual activity at an earlier age than the Poland China, since the Minn. No. 1 hogs show the greater response to sex, it raises grave doubts whether our standards of appraising boars with the eye are always what they should be. Selecting boars by barrow standards over a long period of time may well lead to low sexual activity and lowered fertility as a whole.

This study has made it clear that other fundamental factors are involved in the differences demonstrated. Some of these factors are also being studied and will be discussed in the subsequent papers of this series.

Summary

A total of 86 boar-barrow pairs were measured every four weeks from eight weeks until 24 weeks old or 220 pounds in weight.

Nineteen of the pairs were Minn. No. 1 hogs (an inbred line being developed from a Landrace-Tamworth crossbred foundation), and the other 67 pairs belonged to six different inbred lines of Poland China hogs.

No significant differences were found between the inbred Poland China lines in their response to the presence and absence of testes, but the Poland China and Minn. No. 1 hogs differed significantly. The Minn. No. 1 hogs showed both earlier and greater sex differences than the Poland China hogs.

Both the Minn. No. 1 and Poland China boars differed from their barrow mates. Each of these differences was small (especially for the Poland Chinas), so small that it is questionable if the eye could detect each difference if taken

independently. It appears that the differences tend to accentuate one another.

It appears that the testes first accelerate increased weight but that at puberty some other factor enters in and has a depressing effect.

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INCREASING THE EFFECTIVENESS OF LIVESTOCK CLUB WORK

L. C. MADISON[1]
The Pennsylvania State College

A NEED for some measure of achievement was felt early in the development of livestock club work. The livestock show was the generally accepted standard for measuring excellence in livestock so it was only natural that club agents turned to the show ring as a measure of success in their projects.

It is generally agreed that improvement of the club member is more important than producing a show ring champion in a livestock project. It became apparent that placing so much emphasis on the animal was a handicap and that some change was needed so that the educational value and interest of the project to the member would be improved. A survey of twenty leading swine producing states indicated that the method of conducting projects was quite uniform and not very different from the plan in use in Pennsylvania. Without exception, the factor which determined the final score or placing of the member's project was the individuality of the animal. Most states provided members with instructions and information on best production methods, but members were given little credit for electing to follow this advice.

One of the first principles in teaching is to make the task sufficiently difficult to demand work, yet easy enough to be attained by the average member of the class. When the goal is winning first place in the show ring, a goal is set which can be reached by only one member. The emphasis on first prize is out of all proportion to its importance, and the disappointments of those who fail more than offsets any benefit to the winner. Many lose their enthusiasm early in the club period when they realize that there is no chance of winning, and often drop out. The importance of competition is recognized and is a valuable asset if properly directed. The goal of competition should be to excell in feeding, management, and marketing practices.

Even if winning first place were the most desirable goal, is there any way of being sure that the proper animal wins? The author recently attended three swine type conferences. Practically every class created an argument. In one case placings were obtained from four of the leading college judges and one leading breeder in advance, and no two agreed. After much discussion, the judging committee made an official placing which was still different.

[1] Livestock extension specialist. State College, Penn.

Since the placing depends upon the individuality of the animal over which the member has relatively little control, and upon the judge who must make the placing, why should so much emphasis be placed upon the show ring winning in evaluating a member's work?

Another reason for setting a different goal is that less than one-half of one per cent of all club members ever go into the purebred business or become professional showmen, but all who later go into farming and produce livestock commercially need to know the best methods of feeding, management, and marketing. If these lessons are to be taught, then they should be the principal factors in determining the final rating of the member.

Developing a Procedure

To develop a new procedure, a leading livestock county was selected in which county agent and club leaders agreed to cooperate. A management score card was worked out with different weights or values for the various feeding and management practices, based upon estimates of their relative importance. Experience showed that some items such as shade and shelter were taken care of without urging, while it was very difficult to convince members of the importance of other phases such as the value of pasture in swine production. Consequently, the score card was revised to give more emphasis to those items which a large number of members had a tendency to neglect. The card was revised three times before it reached its present form. To some, it might appear unbalanced, but it is producing the desired results under the conditions where it is being used.

In practice, the local leader or person who is to do the scoring visits members shortly after work is started. The score card is explained, and points most apt to be neglected are emphasized. The members and parents are made to realize that there will be a penalty for neglect and a reward for conscientious effort. Actual scoring is done at a later visit. Average daily gain is considered. A feed and financial record is required but economy of gain is not included in the score as this is difficult for members to determine accurately. Credit is also given for fitting and showing an animal at the round-up, and for answers to a series of pertinent questions on the principles of good feeding and management practices. In all, over 90 per cent of the score is based upon what members have done and learned, and the balance is determined by the individuality of the animal.

The animals are not placed in one, two, three order as is done for professional showmen, but are graded on a market classification basis. They are first weighed and divided into five weight classes, then graded (prime, good, and fair) within each weight group, and all the animals of the same weight and grade receive exactly the same score for individuality. During the five

years that this method of scoring has been followed, no criticism of this procedure has been raised by members and parents. The member becomes acquainted with the way animals are graded on the market and with the type that brings top prices. This method of grading familiarizes the members with market requirements and the differences in prices of different grades of animals in the sale emphasize the lessons taught in the grading demonstration.

When enough pigs are available to make a sale practical, all animals are sold according to weight and grade, thus acquainting members with selling procedures and further emphasizing the value of producing the proper type. This has proved such a valuable addition to the project that when there are not enough animals in a county to justify a sale, district round-ups are established for several counties, in order to insure a successful sale.

When final scores are compiled, members are not placed one, two, three, but receive awards on a merit basis. First merit award goes to those scoring 90 to 100, second to those scoring 80 to 89, and third to those scoring 70 to 79. If cash prizes are available, they are divided equally among the members within the respective merit groups. This places the emphasis where it belongs, recognizing equally all those who have made a conscientious effort and done a good job.

After the round-up is over there is nothing to prevent a member showing his animal at fairs in open or special classes.

Results Obtained

It was soon observed that the new procedure was resulting in higher quality work, due to an increase in interest and enthusiasm of the club members. It also appealed to county agents, parents, and club leaders. Increase in the number of clubs and members was more rapid than anticipated. An indication of this increase is given in table 1.

TABLE 1.—COMPARISON OF RESULTS OBTAINED IN USING OLD AND NEW PROCEDURES IN PIG CLUB PROJECTS

Basis of comparison	Average for 12 years under old plan	Fifth year under new plan	Increase (in per cent)
Counties carrying projects*	15	52	250
Total clubs in State	25	175	600
Total members in State	250	1,892	650
Total number of meetings	84	960	1,050
Total attendance	2,473	22,490	900

* There are 67 counties in Pennsylvania. Fifteen of the mountainous counties have so few hogs that they are of no commercial importance.

The rapid increase in numbers of clubs and membership, the improvement in quality of work, and the observed effect of changing and improving farm practices in those communities where clubs were organized on this basis, offer convincing evidence that the placing of emphasis on efficient feeding, management and marketing practices is a practical tool in livestock club work, and that it is a distinct improvement over the practice of rating members on the show ring winnings of the animals at the round-up.

PRESIDENT'S ADDRESS[1]

W. H. Peters
University of Minnesota

SINCE the last meeting of our Society, the Government of our country has found it necessary to give ever increasing attention to the problems that have been brought upon us by the armed strife that is taking place on the continents of Europe, Asia, and Africa. Every member of this Society is familiar with the program that is going forward to insure the defense of our country and to provide supplies to other countries that are fighting to maintain the same sort of independence and freedom which we prize.

As we come together for this the thirty-fourth annual meeting of our Society, we find that many of our younger members have enlisted or been called into military training by selective service. Many others have dropped their regular work temporarily to assume positions of leadership and guidance in essential though non-military phases of the defense program. Many students in agricultural colleges have enlisted or been called into training by selective service. More members and more students may need to interrupt their planned programs to serve their country in a more direct way before the threat to our liberty is overcome. I wish to express gratitude and pay tribute to those members of the Society who are absent from the meeting this year because they are engaged in military service, or other work in the defense program.

All members of the Society are engaged in defense work by being employed in some phase of the livestock industry. Food products of animal origin are of major importance in the maintenance of an armed force and in the diet of industrial workers who manufacture the equipment and munitions required by the armed forces. Because of their highly concentrated form and semi-perishable keeping quality, food products of animal origin are adapted to shipment to foreign countries where they are needed.

American livestock producers have been asked by their government to maintain the production of nearly all livestock products at the level of the last several years. They have been asked to appreciably increase the production of hogs, dairy, and poultry products. As leaders of thought in the field of livestock production and originators of many of the methods now followed by livestock producers in practice, members of this Society have a

[1] Delivered before the Thirty-fourth Annual Meetings of the American Society of Animal Production. Nov. 28–30, 1941. Chicago, Illinois.

large responsibility in helping to carry out the production program that has been requested by our Government.

Many methods essential to efficient livestock production have been made available to livestock producers through financial support of research and agricultural education, by federal and state governments during the last seventy-five years. Past and present members of this Society have played a large part in the discovery and dissemination of the knowledge upon which the improved methods of production are based. Progress in a normal program of work must be temporarily interrupted for some, and will be handicapped for others, through the duration of the present national emergency. Because of this it is important that those of us who are left undisturbed in our positions carry on with energy and diligence so that progress in our chosen field of endeavor may go forward with the smallest necessary interference.

Before beginning the preparation of this paper I read the presidential addresses that were given by the presidents at each of the annual meetings for the last ten years. I also reviewed the programs that were given. My object was to note those problems that had been pointed out by the presidents and indicated by the programs as calling for most urgent attention by the members of the Society. I then tried to put in one list those problems that could be considered solved, in another those on which progress had been made, and in a third those needing most urgent attention at the present time. I was much impressed to find that some of the problems considered perplexing as recently as eight to ten years ago have since been rather thoroughly solved. I was impressed by the progress that has been made on many problems in research that were discussed before the Society the first time on some program during the last ten years. I was impressed most by the breadth of the field of animal husbandry as evidenced by our annual programs of recent years. In my judgment the trend of the programs of our annual meetings during the last ten years, toward a broader coverage of the vast field of our profession and an increasing percentage of reports of experiments involving fundamental research is proof of progress being made and greater progress to come in the future.

In the presidential address in 1933, Professor George Humphrey said, "Our greatest difficulties at this time and in the next twenty-five years will be in breaking down old traditions and discovering new means of overcoming prejudices and indifferences on the part of ourselves and others." In making this statement I think Professor Humphrey had in mind the newer knowledge that was then just beginning to come to light concerning such subjects as the significance of the amino acids, the need for minerals in animal nutrition, the existence of vitamins and their uses, the possibilities of artificial insemination, the application of genetic principles to animal breeding

practice and other new discoveries which in his mature judgment he foresaw would necessitate radical changes in many long established livestock production practices. I believe that new knowledge concerning many phases of livestock production has been gained more rapidly than Professor Humphrey or any of us thought it would be and I believe the old traditions and prejudices are breaking down more rapidly than he thought they would. There is still too much indifference toward progress on the part of many livestock producers and perhaps on the part of some of us.

To me one of the most promising indications of more effective research and more rapid progress to be made in the near future is the realization by research workers that progress in animal husbandry is dependent upon progress in a number of sciences upon which it is based, notably biochemistry, genetics, physiology, veterinary medicine, agronomy, and economics. I think that in most experiment station staffs, the realization of the interdependence of workers in all of the above mentioned fields is mutual.

During the last ten years many research projects have been planned at many experiment stations calling for cooperative effort between workers in several different fields. For instance, livestock feeding experiments and research projects in nutrition should be cooperative between animal husbandry, biochemistry, and veterinary medicine. Experiments in animal breeding should be cooperative between animal husbandry, genetics, and veterinary medicine. Experiments with pasture problems require the cooperation of the agronomist, plant breeder, botanist, veterinarian, biochemist, and animal husbandman.

The Association of Land Grant Colleges and Experiment Stations has been quick to note the advantages of cooperative effort in research. It has advantages from the standpoint of administration as well as from the standpoint of thorough productive research. In the study of some problems of regional or national scope and of such magnitude that no one experiment station can hope to cover all of the work to be done, administrative officers are ready to offer the resources of their experiment stations for cooperative effort. The most outstanding and most recent illustration of the planning of a project in research from a broad cooperative standpoint is the project initiated at the recent meeting of the Land Grant Colleges in which it is proposed to study the vitamin A content of milk.

The Land Grant Colleges appointed an executive committee composed of persons in administrative positions in several of the colleges and experiment stations and instructed them to do something about the problem of the vitamin A content of milk and butter. This committee in turn is now engaged in forming a committee of experts and specialists that will soon begin a study of the vitamin A content of milk. The first assignment to this committee will

be to bring together and organize all of the knowledge now available concerning the vitamin A content of milk. The next step will be to distribute work on different phases of the problem to those experiment stations and to those workers best equipped, best qualified and most willing to do it. In my judgment, a number of the problems in our field might well be approached in much the same manner. Some are already being approached after this pattern, notably those being studied by the regional laboratories. Progress in research in animal husbandry in the years of the immediate future is dependent more than anything else upon acceptance of a broader view of the scope of our field, its interdependence upon progress in many related fields and upon our willingness to cooperate with workers in other fields and at other experiment stations in the promotion of sound, well planned, comprehensive, fundamental research projects.

All members of the Society are more or less familiar with the plans, that have been in the making through the last several years, to begin the publication of a quarterly Journal. At the annual meeting last year, the Society instructed the executive committee to proceed with the appointment of an editorial board and to make arrangements for the publication of a Journal, the first issue to appear early in 1942. The executive committee carried out the instructions to the best of its ability. In the appointment of the editorial board, an attempt was made to select members who were well qualified, who were interested to see a Journal succeed, and who could devote the necessary time and effort to the large task of formulating a sound editorial policy. The editorial board appointed responded enthusiastically to its task. Plans and arrangements are complete and the first issue of the JOURNAL OF ANIMAL SCIENCE will appear next February. The report of the chairman of the editorial board to be given at the business meeting tomorrow will outline the plan it is proposed to follow in the publication of the Journal. On behalf of the executive committee I wish to express our thanks to Dr. R. W. Phillips, Chairman of the editorial board, to other members of the board, and to Secretary Weber for the thoroughness of their work in bringing the development of the Journal along on schedule.

It is my hope that the publishing of the JOURNAL OF ANIMAL SCIENCE will accomplish much in taking up the lag that is said by some to occur between the first announcement of useful experimental results and their general application in practice. I do not propose to pass judgment upon how serious this lag may be or whether it exists at all. The statement that such a lag does exist has been made from several sources. At least the publication of the Journal will offer an opportunity to announce important research findings at quarterly intervals.

At present the membership numbers about 500 persons, most of whom are

employed in the agricultural colleges and experiment stations of the United States and Canada and in the federal departments of agriculture in the two countries. If the Journal is to serve the purpose of promptly disseminating research findings to all who should receive them our membership or at least the circulation list for the Journal must be greatly increased. There is a large opportunity to increase our membership and a larger one to build up a long list of subscribers to the Journal. The addition, to the annual meeting, of a sectional program devoted to industry for the first time last year and its continuation this year has opened the way to the soliciting of memberships from a considerable number of persons employed in industrial research departments. There are many men with college training engaged in livestock breeding or employed by agencies associated with it such as the registry associations and breed journals. The time may be at hand when the Society could benefit from a closer contact with this group, and an attempt to secure more members from it might be in order. It is my understanding that the district branch associations do welcome and have in attendance some livestock breeders.

Our largest opportunity to increase membership or to build a large subscription list for the Journal rests with the hundreds of county agricultural agents, teachers of agriculture in high schools, soil conservation workers, and social security field agents. While only a part of the time of this large group of workers is given to problems in livestock production, they are the people in a position to take up the lag between the announcement of research findings and getting them into use on farms. It is not so important that they be members of the Society but it is important that they receive the results of research work in animal husbandry promptly. I am hopeful that as the Journal gets under way, it will be possible to get a large percentage of this group on the subscription list.

To develop a strong Journal, with a long subscription list, will require a great deal of work. Much of it must be done gratis by members who are elected to official positions and appointed to committee memberships. In the past the heavy burden of managing the affairs of the Society has been delegated to the secretary. During the entire time that I have been a member we have had efficient secretaries who have done their work just as though they were being paid for it. The comment I wish to make in closing is that the task of administering the affairs of the Society is growing enormously with each succeeding year. The time is approaching when part of the income of the Society will need to be used to pay for some of the administrative work. Every member should accept the responsibility of doing his bit to help the secretary secure new members and subscriptions to the Journal.

ABSTRACTS OF PAPERS PRESENTED AT THE THIRTY-FOURTH ANNUAL MEETINGS OF THE AMERICAN SOCIETY OF ANIMAL PRODUCTION

Opening Session

W. H. Peters, *presiding*

THE DESIGN OF ANIMAL HUSBANDRY EXPERIMENTS. E. W. Crampton. *Macdonald College (McGill University).*

Animal Husbandry Experiments for the most part involve data too extensive and too complicated to be satisfactorily described or analysed without employment of statistical methods. Use of these methods imposes certain restrictions and conditions on the data, and accordingly on the design of the experiment. Indeed, a particular experimental design is primarily a means of ensuring data which may be efficiently analysed by some statistical procedure. For a considerable number of tests, a factorial desgin proves exceedingly useful from the standpoint of efficient use of the experimental animals and the precision of the analysis. Such design makes it possible to include a measure of the interactions between primary experimental treatments, thus permitting a more comprehensive interpretation of results than can be justifiably made from consideration of the primary comparisons alone. "Statistical control" of variables correlated with the criteria on which the effects of imposed experimental conditions are judged has proved advantageous in increasing the precision of many types of Animal Husbandry trials. Effects of such factors as initial weight or feed intake on gain may be taken into account by this method. An extension of the use of simple regression permits critical study of the relative and the combined effects of several independent variables on some dependent factor under consideration. Thus one might evaluate the importance of a group of factors as rate of gain, or length of pig, on some particular characteristic as the per cent lean of a bacon rasher. The number of independent variables considered is limited only by the practical considerations of time and facilities for the mathematics involved. It is emphasized that statistical methods are tools which, when intelligently employed, permit the animal husbandry experimentor to do with more precision and efficiency the often difficult job of interpreting the results of his research.

THE APPLICATION OF GENETIC PRINCIPLES TO ANIMAL BREEDING PROBLEMS. P. W. Gregory, *University of California.* (No abstract available)

PROBLEMS IN HUMAN NUTRITION. Robert F. Griggs, *George Washington University.* (No abstract available)

THE PHYSIOLOGICAL APPROACH TO LIVESTOCK NUTRITION PROBLEMS. L. A. Maynard, *Cornell University.* (No abstract available)

Sheep and Wool Section

F. S. Hultz, *chairman*

THE EFFECT OF ENVIRONMENTAL VARIATIONS ON GROWTH OF NAVAJO LAMBS. Cecil T. Blunn, *United States Department of Agriculture, Ft. Wingate, N. M.*

This study comprises an analysis of live weights on groups of Navajo lambs taken at 28 day intervals from birth to weaning age for the past four years at the Southwestern Range and Sheep Breeding Laboratory, Fort Wingate, New Mexico. The lambs were born during the middle two weeks of May and had a range in age of one week on either side of the mean. They were divided into sex and type of birth classes.

Significant differences were found between the mean monthly weights for the several years. These began at birth in the case of single and twin ewe lambs and at one month for single and twin rams. In accounting for the total variance of any class for each month the variance between years proved to be of greater importance than that within years. An analysis of the data on lambs produced by the same sires showed that the variance between years was as great when lambs from the same dams were compared as when all lambs sired by these rams were compared. Furthermore, the variance between years in this select group was almost as large as it was in the entire population. The differences between yearly weights apparently were directly related to range forage conditions which in this semi-arid country vary greatly from year to year.

THE USE OF COTTONSEED MEAL IN THE RATION OF PREGNANT EWES. H. M. Briggs, *Oklahoma Experiment Station.*

A two year study has been completed on the feeding of previously reported excessive levels of cottonseed meal for pregnant ewes. Sixty ewes have been used each year, one-half of which have received levels of .25 lbs. cottonseed meal daily while the others received .50 lbs. daily. Both the high and low levels of the meal have been fed with both alfalfa and prairie hays. Varying amounts of whole oats have been used to keep the lots gaining at approximately the same rate during the experimental feeding period. Purebred Hampshire ewes and grade Western ewes have been studied separately on the rations.

Equally satisfactory performance has been experienced on the high and low cottonseed meal rations. One abortion was observed on a low meal ration. Prairie hay compared very favorably with alfalfa hay as a roughage at both levels of cottonseed meal when .25 oz. finely ground limestone per head daily was added to the grain mixture of those receiving the non-legume hay. Ewes have been on the experimental rations varying lengths of time from a minimum of 43 days to a complete gestation period. Lack of uniformity in conception has made the variation in experimental feeding period unavoidable.

Carotene determinations the second year showed that the prairie hay used had 18.7 p.p.m. and the alfalfa hay 30.0 p.p.m. The cottonseed meal and oats contained none.

STUDIES ON IMPORTANT EXTERNAL PHYSICAL CHARACTERISTICS OF WOOL. M. E. Ensminger, *Massachusetts State College.*

The scouring, density, length, and diameter of fiber were determined for the nine body areas as follows: head, neck, shoulder, back, side, belly, rump, upper thigh, and lower thigh. On the basis of the statistical analysis, it appears possible to reduce the wool character distributions to a common plan, ranking the groupings from the most desirable to the least desirable character attribute as follows: (A) Quality (finest to coarsest): (1) the head wool, (2) the dominant or bulk wool, and (3) the rump and britch wool. (B) Length (longest to shortest): (1) the lower britch wool, (2) the dominant or bulk wool, and (3) the head wool. (C) Density (most dense to least dense): (1) the head wool, (2) the neck and shoulder wool, (3) the dominant or bulk wool, and (4) the belly wool. (D) Per cent clean wool (highest yield to lowest yield): (1) the neck wool, (2) the dominant or bulk wool, (3) the belly wool, and (4) the head wool.

There appears to be somewhat of an inherent gradient in fiber diameter, contour, density, and length from the fore to the rear part of the body, and downward to the belly.

Increased fiber length was associated with a higher per cent yield, increased diameter, and less circularity. It appeared to have little relationship with density.

The standard deviation and coefficient of variation of fiber diameter run consistently high in the rump, upper thigh, and lower thigh; and consistently low in the head. Thus, the body areas having the largest mean fiber diameter show the highest degree of scatter. Scatter in fiber length could not be arranged according to any definite pattern.

EVALUATION OF FLEECE YIELD IN THE IMPROVEMENT OF NAVAJO SHEEP. James O. Grandstaff, *United States Department of Agriculture.*

A comparison of samples from 6 different regions of the fleeces of 144 yearling sheep of Navajo and crossbred strains showed that the rump yielded the highest percentage of clean

wool, the belly was lowest, and the shoulder and side exceeded the mean of all samples by an average of less than 2 per cent.

The correlations between the yields of samples from each region and the remaining 5 regions of the fleece varied from 0.09 to 0.82, yet all but 3 were highly significant. For the group of Navajo ewes, the side sample ranked highest with a correlation of 0.74, followed by the shoulder with 0.64. For 2 groups of Romney and Corriedale crossbred ewes and 1 of Navajo rams, the shoulder sample yielded correlations of 0.68, 0.81 and 0.82, compared with 0.67, 0.76 and 0.80 for the side.

The standard errors of estimate for 1 region on the mean of 5 regions ranged from 3.56 to 9.71, the side or shoulder being lowest for both groups of Navajo sheep.

On the basis of these data it was concluded that yield of the side sample may be used as a practical aid in the selection and breeding of the sheep for increased wool production.

Comparison of the yield of side samples collected at weaning and yearling ages gave correlations of .43 and .25, with standard errors of estimate of 10.34 and 11.22, in two consecutive years. In 1938–39, 67 ewes yielded 85.0 per cent clean wool as weanlings and 59.4 per cent as yearlings. In 1939–40, 127 ewes yielded 76.3 per cent at weaning age and 75.1 at yearling age.

In view of the strong influence of seasonal conditions on wool shrinkage, the weanling samples are of doubtful value for predicting yield at yearling age. The weanling samples may provide an index of sire influence on wool shrinkage, and may, therefore, be of some use in progeny tests.

THE VALUE OF ROCK PHOSPHATE AS A MINERAL SUPPLEMENT FOR SHEEP. J. D. Hatfield, C. L. Shrewsbury and L. P. Doyle, *Purdue University.*

The effects of fluorine in the form of rock phosphate upon fattening lambs have been studied from the standpoints of (1) growth and feed consumption, (2) physical aspects and chemical alteration of the bones and teeth, and (3) the effect upon size, iodine content, and iodine utilization with regard to the thyroid gland. There were no detrimental effects upon growth and feed consumption up to 3.0 mg. of fluorine per day. A level of 6.0 mg. of fluorine per day was definitely detrimental to feeding consumption and consequently to growth. The bones of the fluorine fed animals were larger in volume and physical measurements but weaker and contained an appreciably greater quantity of fluorine. The breaking strength per gram of bone weight decreased very significantly as fluorine was increased in the ration. The percentage of ash increased to a slight extent and the percentage of fluorine increased quite appreciably in going from the low level of fluorine to the higher levels. The size of the thyroid gland decreased very regularly and significantly as fluorine was increased in the ration and the iodine content increased in the same manner. The ratio of the iodine content of the thyroid gland to the iodine consumption (from block salt) was constant in the lots which received fluorine and was significantly less when no fluorine was fed.

THE POSSIBILITY OF HYPERGLYCEMIA AS AN ETIOLOGICAL FACTOR IN FEEDLOT LOSSES IN LAMBS. P. B. Pearson and J. C. Miller, *Agricultural and Mechanical College of Texas.*

Investigations were undertaken as a result of the report by Baker et al. (1931, J. Am. Vet. Med. Assoc. 79: 97–99) that hypoinsulinism is one of the chief factors responsible for feedlot losses in lambs.

The glucose content of the blood of two groups of lambs was determined at regular intervals during the feeding period. In the first group of lambs the average glucose content of the blood at the beginning of the experiment was 49.6 mg. %. After the lambs had been on feed one month the average glucose content was 92.5 mg. %. The lambs went off feed towards the end of the second month and the blood glucose declined to 48.4 mg. %. There was a subsequent increase in the blood glucose after the lambs were back on feed but at no time throughout the remainder of the feeding period did it equal the level at the end of the first month.

The intake of T. D. N. by the second group of lambs remained rather low probably due to the high summer temperatures. There was no appreciable increase in the blood glucose of these lambs during the first half of the feeding period.

In glucose tolerance tests with lambs the percentage increase in blood glucose is essentially of the same order as for humans. However, the maximum levels occurred between 90 and 120 minutes after ingestion of the test dose as compared with about 30 minutes for the maximum in humans. The time required for the blood glucose to return to its normal level was not unduly long as is the case in hypoinsulinism.

RELATIONSHIP BETWEEN WEANLING AND YEARLING FLEECE CHARACTERS IN RANGE SHEEP. Elroy M. Pohle, *United States Department of Agriculture, Dubois, Idaho.*

A study has been made of the relationship between weanling and yearling fleece characters in range sheep to determine the reliability of using weanling instead of yearling value. The use of weanling measures where reliable for evaluating individual sheep at weaning time would be useful in speeding up a sheep breeding program.

A total of 170 ewes consisting of 70 Rambouillets, 50 Corriedales and 51 Columbias was used for this study in the flocks of the U. S. Sheep Experiment Station and Western Sheep Breeding Laboratory at Dubois, Idaho. Two adjacent wool samples were taken and used for both clean yield and density index determinations from the left side of each ewe near weanling age and again from the right side at yearling age. Fineness samples were taken from the front sampling area and on the thigh even with the underline at both ages. Weanling values for fleece length and clean yield were found to be reliable in estimating the yearling outcome in each of the three breeds studied. Fineness of fiber in weanling side and thigh wool shows some predictive value for yearling fineness but is not so reliable as weanling length and clean yield. It is pointed out that fineness determinations for side and thigh wool should be considered individually. Weanling density index has the least predictive value but there was a definite relationship between the two density index of the weanling and yearling wool samples. There was but slight variability between the two adjacent samples taken at the same time for length of fiber, clean yield, and density in the three breeds studied. Results show the possibilities of selecting breeding animals on weanling data. This will prove useful in a wool improvement program.

PERFORMANCE OF EWES BRED FIRST AS LAMBS COMPARED WITH EWES BRED FIRST AS YEARLINGS. D. A. Spencer, R. G. Schott, R. W. Phillips and B. Aune, *United States Department of Agriculture.*

Data were collected on Hampshire ewes born during an eight-year period. One hundred nineteen pairs were studied. Pairing was based on age, weight, and family relationship. One of each pair was to be bred first as a lamb at the age of 9 or 10 months and the other first as a yearling at the age of 18 or 19 months. Eighty-four of the 119 exposed to breeding as lambs actually conceived. This group of 84 was designated group A and the 35 that failed to conceive as lambs were designated as group B. Their pair mates were classified as groups C and D, respectively. Performance was followed for 5 years.

Conception as lambs resulted in lighter weight of ewes at 2 years of age, but this deficiency was overcome by the third year.

Group A produced 89 lambs at 14 to 16 months of age. Total lambs born in groups A, B, C, and D were 427, 135, 370, and 140, respectively, and the totals reared to weaning were 305, 92, 255, and 102.

Average weaning weights of lambs in the 4 groups were 67.0, 68.2, 70.1, and 69.0 pounds, respectively. The average weaning weight of lambs from group A in the first year was 54.3 pounds, the lightest of any group of lambs. Group A produced a total of 2,572 pounds more lambs at weaning than group C.

Average annual fleece weights of the ewes in the groups were 7.9, 8.3, 8.2, and 8.0 pounds, respectively.

THE IMPORTANCE OF BODY WEIGHT IN SELECTION OF RANGE EWES. Clair E. Terrill and John A. Stoehr, *United States Department of Agriculture, Dubois, Idaho.*

An investigation of the selection of range ewes at the U. S. Sheep Experiment Station

and the Western Sheep Breeding Laboratory, Dubois, Idaho, involved the relation of fall body weights of 758 yearling ewes to their lifetime lamb and wool production.

Ewes which were heavier as yearlings consistently weaned more pounds of lamb per ewe year during their lifetimes. The average lifetime lamb production per ewe year, as measured by pounds of lamb weaned at about 130 days of age for the lightest quarter, middle half, and heaviest quarter of ewes as yearlings was 63, 77, and 78 pounds for Columbias; 62, 68, and 75 pounds for Corriedales, and 55, 60, and 69 pounds for Rambouillets. The advantage of the heavier ewes was due more to a higher per cent of lambs weaned than to heavier weaning weights.

Selection on yearling body weight would have about the same effectiveness for increased lamb production within each of the breeds studied. The differences in lamb production between the lightest and heaviest group of ewes was practically the same for each of the 3 breeds. These differences varied from 13 to 15 pounds of lamb weaned per ewe year.

There was an inverse relationship between average lifetime body weight and pounds of lamb weaned per ewe year when considered independently of fall yearling weight. This emphasizes the desirability of basing selection on body weights taken prior to the first breeding.

There was a slight advantage in lifetime average fleece weight in favor of the ewes which had been heavier as yearlings but there was practically no difference in lifetime fleece length.

EFFECT OF LIBERAL WHEAT GERM OIL FEEDING ON THE REPRODUCTION OF SEVERAL BREEDS OF SHEEP. Byron H. Thomas, Wm. F. La Grange and C. C. Culbertson, *Iowa State College.*

During a two-year period data were collected in a paired-ewe experiment to determine the effect of liberal wheat germ oil supplementation on reproduction of purebred ewes of various ages. Moderate numbers of Hampshire, Oxford, Shropshire, and Southdown ewes ranging in age from 1.5 to 6.5 years were used. Each pair was managed and fed similarly previous to and throughout the test. The ewes were limited to pasture (when available) and alfalfa hay, except at breeding time and throughout pregnancy and nursing, when a grain mixture was provided. One ewe of each pair received liberal amounts of a vitamin E-potent wheat germ oil. Sixty cc. were given orally per ewe preceding the breeding season, and 10 cc. per ewe weekly thereafter until each ewe lambed. Ewes which received wheat germ oil comprised Group I; those not fed it formed Group II.

This test included 99 matched pairs, and both ewes of 83 pairs lambed. Among the latter were 20 pairs which lambed during both years. The average amount of wheat germ oil consumed by all the ewes in Group I previous to and during pregnancy was 159 and 360 cc., respectively. The average lambing dates of Groups I and II were March 10th and 6th, and the percentage lamb crops 133 and 137, respectively. In Groups I and II, 9 and 11 per cent, respectively, failed to lamb. When data were re-grouped according to breeds no consistent differences in reproductive performance were obtained. Ewes which received wheat germ oil during both years did not appear to reproduce significantly better during the second year.

These data indicate that liberal amounts of vitamin E as it occurs in wheat germ oil will not significantly improve the reproductive performance of ewes which are fed and managed in accordance with good sheep husbandry practice. Other information accumulated to date indicates that reproductive requirements of sheep for vitamin E are exceedingly small and probably are adequately met by rations usually fed.

FATTENING WESTERN LAMBS AND GUMMER EWES. James C. Watson and Forrest U. Fenn, *South Dakota Agricultural Experiment Station.*

During each of the last three years the South Dakota Agricultural Experiment Station has conducted feeding trials with 50 western lambs and 100 aged, gummer ewes to determine the advisability of feeding gummer ewes culled from range bands or from farm flocks. The results of these trials indicated that it was not profitable to feed aged gummer ewes. Lambs returned a fair margin of profit, while only in exceptional cases did the ewes return a profit and then quite small. Grinding grain for gummer ewes reduced its palatability and its efficiency. Gummer ewes required considerably more feed per one hundred pounds of gain than the lambs.

Corn was a more efficient fattening feed than barley. The ewes and lambs made about the same rate of gain in weight. The quality and palatability of meat from finished gummer ewes compared favorably with that from finished lambs and showed considerable improvement over the meat from unfinished or feeder ewes.

PHENOTHIAZINE AS AN ANTHELMINTIC FOR SHEEP. V. E. Whitehurst, Jr. and L. E. Swanson, *North Florida Experiment Station, Quincy.*

An experimental flock of sheep has been maintained at North Florida Experiment Station since 1933. No losses from internal parasites occurred during the first year; however, beginning with the second year, parasitic infestation became a serious problem. The animals were unthrifty and death losses became greater with the years. Copper sulfate and nicotine sulfate had been administered on numerous occasions in an effort to control the parasites.

In 1940 it was deemed advisable to administer phenothiazine as an anthelmintic. The drug was administered with feed. The sheep were fasted for 24 hours prior to offering the mixture of phenothiazine and feed. Treatment was given at monthly intervals for 14 consecutive treatments. The dose of phenothiazine was a 25-gram allowance for each adult sheep. This dose was mixed in 250 grams, or approximately one half pound, of concentrates. An untreated group was maintained as a control lot.

The treatment of the flock with phenothiazine reduced the death loss from 15.87 per cent in 1939–40 to 1.54 per cent in 1940–41.

The control lot made slightly greater gains during the first four months of the experiment, but lost considerably more weight during lambing time than did the treated sheep. Twelve months after the experiment began the treated sheep continued to make gains in weight from month to month, while the control group lost weight rapidly and began to die as a result of the heavy parasite burden.

Parasites can be controlled in sheep by giving phenothiazine at monthly intervals in feed.

Horse and Mule Section

G. W. Salisbury, *chairman*

SEASONAL INFLUENCES ON THE REPRODUCTIVE PERFORMANCE OF MARES AND JENNETS IN MISSISSIPPI. V. R. Berliner, *Mississippi State College.*

Under the climatic conditions of Mississippi the breeding period of brood mares and jennets is not restricted to a definite season of the year. Only a few cases of anestrus were observed that probably were of a pathological nature. However, seasonal factors affecting the growth of pastures have a definite effect on the estrous periods of both mares and jennets. Observations in four years have shown that before the pastures are at their best stage, and until the animals have recovered from wintering, namely in March and April, their estrous periods have a tendency to be irregular and they may last up to 18 days. In May, June, and July the estrous periods in the majority of cases last 3 to 6 days, and again become longer (7 to 10 days) after August. Abnormally long estrous periods may occur at any time, and are due in most instances to pathological disturbances in the reproductive tract. Mares and jennets with long estrous periods in the early spring may become pregnant if they are bred frequently, but they require more services per pregnancy than those with the shorter estrous periods, pro vided no pathological conditions are interfering with their becoming pregnant. The length of the estrous period at the different seasons has no influence of practical significance on the length of the consequent estrous cycle.

Mares and jennets that become pregnant in the early spring have longer gestation periods than those that are bred after May. For the March and April bred mares the gestation period is always over 350 days, and may last 365 days; for May bred mares it ranges between 340 and 360 days, and for June and July bred mares the range lies between 320 and 350 days. Mares that were bred in March and April, may give birth after a pregnancy period of less than 340 days, but these colts are either dead at birth or die shortly after. Such premature births occur almost exclusively in the early spring. The estrous periods of the jennets are affected to a

lesser degree by the season than those of mares, but the duration of gestation is influenced in the same manner. Spring bred jennets may go up to 380 days, whereas in summer and fall bred jennets the gestation period decreases to 350–360 days.

TWINNING IN HORSES. Leonard H. Blakeslee, Ralph S. Hudson and Harrison Hunt, *Michigan State College.*

Twin foals occur often in horses. Considerable information is found on frequency of twinning in other animals. This report presents original data on twinning in horses. The information which follows is taken from the foaling records of the Michigan State College purebred herd of Belgian and Percheron mares.

The records procured over the past 25 years are on the foaling of 102 mares, 46 of which were Belgian and 56 Percheron.

Four hundred and three parturitions were recorded from these mares, 174 being Belgian and 229 Percheron. In the Percheron herd, 10 pairs of twin foals were dropped. Only three pairs of twins have been dropped in the Belgian herd. The frequency of twins has, therefore, averaged once in every 58 parturitions in the Belgian herd and once in every 22.9 parturitions in the Percheron herd. Combining the two herds, the twinning frequency has been one pair of twins in every 31 parturitions. On a percentage basis, 3.23% of the parturitions have produced twins. Two complete pairs were raised. In all other pairs, one or both were dead at time of foaling.

HORSE PRODUCTION PROGRAMS FOR AGRICULTURAL COLLEGES. R. B. Cooley, *Purdue University.* (No abstract available)

VITAMIN C AND STERILITY IN HORSES. George K. Davis and C. L. Cole, *Experiment Station, Michigan State College.*

Determination of ascorbic acid in the blood and semen of heavy breed stallions and in the blood of mares of both heavy and light breeds have been made over a period of two years. An attempt to correlate the ascorbic acid content of the blood with breeding difficulties gave no definite distinction between good and poor breeding females although the poor breeders averaged lower in blood ascorbic acid.

The value of ascorbic acid in treating sterility in the stallion was tested and in the case of one animal appeared to be demonstrated. In this case administration of ascorbic acid resulted in the production of active sperm and the discontinuation of the ascorbic acid was followed by the production of sperm with poor motility. This cycle was repeated for a total of 5 times.

The ascorbic acid content of the blood in all horses tested ranged from 0.01 mg. per cent to 0.35 mg. per cent with an average of 0.12, mg. per cent. The blood ascorbic acid of poor breeders averaged 0.1 mg. per cent with a range of from 0.01 to 0.18 mg. per cent while that of the good breeders averaged 0.13 mg. per cent with a range of from 0.06 to 0.26 mg. per cent.

The ascorbic acid content of the semen was dependent to a large extent upon the quantity of the ejaculate. The values obtained varied from some samples in which no ascorbic acid could be detected to a high value of 0.41 mg. per 100 cc.

HORSES AND MULES. THE PRESENT SITUATION AND PROBABLE FUTURE TRENDS. Wayne Dinsmore, *Horse and Mule Association of America.*

The situation for draft horses, their grades, and mules is improving. Pleasure horses are irregular: show horse prospects are as high as ever, on the average, good usable riding horses selling from $150 to $350 are in stronger demand, and show some gain in price: middle class horses which usually sell from $500 to $1200 are less in demand and lower. Race horses are slightly lower in both runners and trotters, but demand is wider. Runners especially show a greater number of owners due to the establishment of racing in more states and more year round racing. Demand for race horses will continue, but may be lower because of heavy Federal taxes on large incomes.

The market for riding horses is steadily broadening because of increase in riding all over

the United States; but 90% of the demand probably will be for gentle, well broken, usable riding horses at $300 or less. Because of economy of production most of our future riding horses will probably come from Western ranges, where they are used under saddle from 3 to 6, then sold because younger stock is coming on.

Draft horses, their grades and mules are manifesting improvement, principally because of: (1) The likelihood that tractors and repairs may be difficult to obtain in the next few months. (2) Fear that taxes on gasoline and other fuels will be increased. (3) Accumulating evidence that farmers who hold fast to horses and mules are better off financially, in the long run, than those who have mechanized farm operations. How long the improvement in demand and prices for work horses and mules will continue will depend upon how long the war continues, and how far priorities or allocations restrict the production of tractors, repairs for same and the taxes on internal combustion fuels. Prices on work stock may advance substantially between now and next April.

After the war the plant capacity now producing tanks will be turned in part at least to production of tractors. We may see a sales campaign to sell tractors, adapted to smaller farms, at lower prices, on easy terms. This will have a detrimental effect on demand and prices for work stock.

BREEDING AND DEVELOPMENT OF MEDIUM WEIGHT DRAFT HORSES. R. S. Hudson, *Michigan State College.*

There are 28 colts in the Project, divided according to type into lots. Twenty (10 light weight and 10 heavy weight) of these received 1 lb. of grain, ear corn and oats, equal parts by weight, and approximately 1 lb. of hay daily the first winter as weanlings and ½ lb. of grain and 1¾ lbs. of hay per 100 lbs. live weight daily the second winter. There are 6 colts that have never received any grain, but have pastured with the others during the summer, and wintered on mixed alfalfa, clover and timothy hay from stacks in the winter. Two colts have been confined entirely to box stalls, have received no exercise or pasture, and everything they have eaten has been weighed. The colts in all three lots are thrifty and have made substantial gains since the report given in the 1939 proceedings.

Average weaning weights (Nov. 15, 1939) in the four groups were 575, 665, 700 and 583 pounds respectively. On July 23, 1941 the weights were as follows: 1308, 1438, 1423, and 1370 lbs.

Colts have been divided into lots and feet have been trimmed at 6, 12, 18, 26, 52 week intervals and one lot with no trimming at any time. Some conclusions to date are: 1. The colts selected as medium and heavy types are making gains consistent for weight expected at maturity. 2. It appears possible to select colts at weaning time which will generally grow true to to type. 3. Grain feeding seems unnecessary for developing work horses when good pasture and roughage are available. 4. Trimming oftener than 12 or 18 weeks appears unnecessary depending on texture of foot and amount of exercise colts are receiving.

LIGHT HORSE PRODUCTION AND THE COLLEGE PROGRAM, E. A. Trowbridge, *University of Missouri.* (No abstract available)

Beef Cattle Section

Bruce R. Taylor, *chairman*

WINTERING THE BEEF HERD. W. G. Kirk and R. M. Crown, *University of Florida.*

Sugarcane is adapted to many Florida soils and produces a larger yield of green forage than do most other forage crops. Carpet grass has been widely used in the improved pasture program. Since sugarcane and carpet grass are grown extensively it was thought advisable to determine their value as roughage feeds for wintering beef cattle. Preliminary trials showed that sugarcane in round shocks of one ton each or placed against upright supports at various depths were the best methods of storing fresh cane. Sugarcane stored by these methods kept

well for several months, and when cut into one inch lengths before feeding, there was no refusal.

Sugarcane as silage and as shocked cut forage and carpet grass pasture were the roughage feeds used in three wintering trials of 105, 113 and 98 days respectively with beef cows; 28, 29 and 30 cows being used in the lots. Forty-one per cent cottonseed meal was used in all trials. The cows had free access to common salt, bonemeal, and "salt sick" mixture, containing 100 pounds salt, 25 pounds red oxide of iron, 1 pound copper sulphate, and 1 ounce cobalt chloride.

Average losses per cow during the trials were 44, 4 and 78 pounds respectively in the three lots. When the weights of 15, 15 and 14 calves raised in the three lots were considered the total gains in the three lots were 467, 1417 and −377 pounds respectively. Average daily consumption of silage was 38.05 and of cut sugarcane 33.75 pounds. Cottonseed meal consumption was 2.21, 2.21 and 2.26 pounds, respectively.

A DISCUSSION OF LENGTH OF FEEDING PERIOD IN BEEF CATTLE RECORD OF PERFORMANCE TESTS. Bradford Knapp Jr. and W. H. Black, *United States Department of Agriculture.*

The question of length of feeding period has been raised in beef cattle record of performance tests and this study was undertaken to answer the question as to how long a feeding period is required to evaluate properly the progeny of beef bulls.

In this study, data on 62 calves sired by three bulls at the U. S. Range Livestock Experiment Station, Miles City, Mont., were used for the analysis. A period of the first 168 days on feed was selected for the short-time period since this is approximately one-half of the entire feeding period.

Analysis of variance study of efficiency of gain indicated that although significant differences ($P < .01$) between sires were observed for the entire period, there was not a significant difference between sires in the 168 day period unless corrections in initial weight were made by covariance analysis.

Using the method proposed by Titus (J. Agr. Res. 48: 817–835), in which the expected efficiency at any weight may be calculated, it was concluded that enough points must be used to determine the regression of efficiency on mean weight and that a period of 168 days is sufficient for this need.

It was also found that the shorter feeding period would result in lower carcass grade but that corrections for total gain in the feed lot may be made.

Thus the total performance of a steer, efficiency of gain or feed utilization, and carcass grade can be corrected to a standard weight and gain from a short-time feeding period.

TWO METHODS OF UTILIZING BLUESTEM GRASS IN FATTENING YEARLING HEIFERS FOR MARKET. C. W. McCampbell and A. D. Weber, *Kansas State College.*

Previous tests conducted at the Kansas Agricultural Experiment Station have shown that purchasing good quality heifer calves in the fall, wintering on good quality roughage plus one pound of cottonseed meal and one-tenth of a pound of finely ground limestone per head daily, grazing without other feed until August 1, then full feeding 100 days in a dry lot, is a satisfactory method of fattening yearling heifers for market.

The question was raised by a group of Kansas cattle feeders as to whether it might not be better to feed three to four pounds of grain during the wintering phase, start full feeding on pasture about July 1 and continue the full feeding in a dry lot after August 1.

A comparison of these two methods of handling heifers was made at the Kansas Station during the year 1940–41.

Both lots showed satisfactory margins over and above cattle cost plus feed cost at the close of the experiment—$23.75 per head for lot 1 fed no grain during the wintering phase and $20.22 for lot 2.

Lot 1 showed a larger margin at the close of the experiment November 8, also when each had reached the same degree of finish—November 8 for lot 1 and September 29 for lot 2.

Lot 1 consumed more roughage and less grain but lot 2 could have been marketed earlier than lot 1.

GRAZING WINTER WHEAT WITH SPECIAL REFERENCE TO THE MINERAL BLOOD PICTURE. Warren N. McMillen and Wright Langham, *Panhandle Agricultural Experiment Station, Goodwell, Okla.*

During the 1940–41 wheat grazing season, studies were conducted to establish the value of wheat pasture for Hereford calves. In this study special attention was given to weight gains, mineral blood picture, chemical composition of the growing wheat and possible relation of these factors to the occurrence of grass-tetany and milk fever.

Chemical analysis showed growing wheat to be an excellent source of calcium, phosphorus, magnesium and protein. Before March 25 the calcium-phosphorus ratio was 1.1:1 and after March 25 0.8:1.

Hereford calves grazing wheat pasture made slightly better daily gains over a 106-day period than did the control lot fed dry-lot wintering ration. Calves receiving bone meal and ground limestone failed to make more gain than those on wheat pasture alone. Calves receiving dry forage in addition to wheat pasture and mineral supplement made slightly larger gain than those receiving no dry feed.

Analyses of blood for serum calcium, phosphorus, and magnesium failed to show any definite results that might be correlated with animal disorders resulting from grazing wheat. Blood phosphorus was lower for the calves on wheat pasture than for those in dry lot. Serum magnesium of animals receiving wheat alone was lower than that of the animals receiving mineral and dry feed.

Blood analyses from six cases of milk fever or grass-tetany occurring on wheat pasture showed that serum calcium and phosphorus of stricken animals was low and serum magnesium high. As a result of treatment with calcium gluconate, serum calcium and phosphorus was increased while serum magnesium remained essentially unchanged. Consideration of Ca:P, Mg:P, Ca:Mg and Ca plus Mg:P ratios in these cases failed to show any uniformity either before or after treatment. This further supports the belief that "wheat poisoning" and milk fever may be complex nervous or glandular disturbances instead of simple mineral deficiencies.

SOME TEXAS LIVESTOCK SCENES INCLUDING SANTA GERTRUDIS AND BRAHMAN CATTLE. D. W. Williams, *A. and M. College of Texas.* (Motion picture)

Dairy Cattle Section

W. E. Petersen, *chairman*

THE INFLUENCE OF INBREEDING ON BIRTH WEIGHT, RATE OF GROWTH, AND TYPE OF DAIRY CATTLE. J. W. Bartlett, R. P. Reece and O. L. Lepard, *N. J. Agricultural Experiment Station.*

In connection with the Holstein-Friesian breeding experiment now in progress at this station data have been collected on birth weights and rate of growth since 1935 and type classifications have been made since 1936. Progeny of the foundation animals were bred as follows: (a) sire-daughter matings; (b) brother-sister matings; (c) matings with less than 50% of the same blood; and (d) outbred. The last system of matings has furnished adequate controls for the breeding experiment.

To date birth weights are available on 76 inbred and 76 outbred calves. In general there was a tendency for all of the animals to be above the Ragsdale standard at birth. The inbred calves were 4 lbs. heavier at birth than were the outbred calves; this difference is not significant. The inbred daughters of two inbred bulls were heavier at birth than were their outbred daughters (a difference of 11 lbs. and 18 lbs.). Four inbred descendents of one foundation cow averaged 22 lbs. heavier at birth than did her 3 outbred descendents but the 4 outbred descendents of a second foundation cow averaged 10 lbs. heavier at birth than did her 5 inbred descendents.

After 5 months both inbred and outbred animals tended to drop below the Ragsdale standard. At 22 months both groups were 16% below normal for body weight and 3% below

normal for circumference of chest. Outbred heifers were 3% below normal for height at withers while the inbred animals were normal for this measurement.

There has been a steady improvement in the type of the animals.

PEANUT MEAL FOR DAIRY CATTLE. F. R. Edwards, *Georgia Experiment Station.*

The attention of livestock producers has been drawn to the possibilities of peanut oil meal as a feed because of its increasing production during recent years. During the past 10 years production has increased more than 500 per cent. Latest available figuers show that more than 500 million pounds of peanuts are being used annually for this purpose. This increase is due to changing economic conditions, to the A.A.A. program, and to the increasing demand for peanut oil.

Peanut meal appears to be especially valuable as a high-protein feed in the rations of cattle and is recommended particularly for dairy cows. Its palatability, high quality of proteins, and its oil content make it a valuable feed for this purpose. Little research has been done with this feed for milk production.

Results of a test carried on under carefully controlled conditions indicate that peanut meal is somewhat superior to cottonseed meal as a high-protein feed in the dairy ration. This test was made with eight cows in matched pairs by the reversal method over a 112 day period. The two meals, peanut and cottonseed, were almost identical in their percentage contents of crude protein and they composed 25 per cent of the two rations, respectively. From the results obtained the feed costs for butterfat production were 31.25 cents per pound when peanut meal was used and 22.27 cents with cottonseed meal. No bad results were observed.

ACCURACY OF LIVE WEIGHTS OF DAIRY COWS ON PASTURE. R. E. Hodgson and J. C. Knott, *Bureau of Dairy Industry and Washington Agricultural Experiment Station.*

The experimental error, the standard deviation of daily trends and the standard error of three-day initial and final live weights of cows on pasture have been determined by analyses of variance. The experimental error of 46 weight groups was 14.0 pounds with a range of from 7.0 to 28.3 pounds. The standard deviation of day to day trends of the groups of cows averaged 7.7 pounds with a range from 0.5 to 20.8 pounds. The standard error of the live weights of cows weighing about 1200 pounds averaged only 2.2 pounds. The experimental error, standard deviation of daily trends and standard error of the initial and final weights were of about the same order.

THE VALUE OF MOLASSES- AND PHOSPHORIC ACID-ALFALFA SILAGES IN THE RATIONS OF DAIRY COWS. W. A. King, G. C. Patrias and W. C. Russell, *Rutgers University.*

Molasses-alfalfa and phosphoric acid-alfalfa silages were fed alone to two groups of three cows each in a continuous feeding trial. Limestone, sufficient to neutralize one hydrogen of the phosphoric acid, was fed for a period of 28 days to the group receiving the acid silage alone. Digestibility trials and balance studies of nitrogen, calcium and phosphorus were run several times throughout the feeding trial. Similar studies were made on two more groups of cows fed the two silages supplemented with hay and grain.

A very significant difference was found in the nitrogen balances of all cows according to the method of analysis of the silage. When corrections were made for the volatile acids and bases lost upon drying the silages, and nitrogen determinations were made on the wet samples of silage and feces the daily nitrogen balance changed as much as 20 grams. All nitrogen analyses were run on both wet and air-dried samples. These results definitely show that all nitrogen determinations of silages and feces should be made on the wet samples and that volatile acids lost upon drying should be accounted for.

With the exception of one period all the calcium and phosphorus values were negative with the cows fed the phosphoric acid-alfalfa silage even when 150 grams of limestone were fed daily. The cows received 4 times more phosphorus and 6 times more calcium than their calculated requirement. On the other hand the balances were all positive, with the exception of one cow, when molasses-alfalfa silage was fed, in spite of a much lower phosphorus intake.

A comparison of digestibility values for the silages when fed alone and when supplemented with hay and grain show only small differences between the two methods with the alfalfa silages under investigation.

THE RELATION OF CAROTENE INTAKE TO BLOOD CAROTENE VALUES OF DAIRY CATTLE. A. H. Kuhlman and W. D. Gallup, *Oklahoma A. & M. College.*

Observations on the carotene content of the blood plasma of dairy cattle in relation to age, carotene intake and other factors have been continued with several groups of Jersey calves from birth to the age of two or more years. The general procedure has been to maintain carotene intakes somewhat above the minimum requirement of 30 micro. per kilo. body weight. Prairie hay, which was offered as soon as each calf showed a desire for it, was the only source of carotene in the ration except during the milk feeding period. The amount of hay for different calves was regulated so as to constitute approximately a full, a 50 per cent and a 25 per cent normal hay allowance. A commercial extract of carotene in capsules was administered daily in different amounts to a few calves that received limited hay rations and to others that received no hay.

Carotene intake and plasma carotene values, in general, followed hay intake, exceptions being produced by seasonal variations in the carotene content of the hay. Constant carotene intakes were maintained in animals receiving the carotene concentrate. Carotene was not detected in the blood plasma of calves at birth. After thirty days it increased with carotene intake and was usually higher per unit of carotene intake in animals 18 months to 2 years of age than in younger animals.

Growth responses of young calves were entirely satisfactory at all levels of carotene intake, ranging from an average daily intake of 22 micrograms per pound body weight to 180 micrograms between the ages of 91 and 180 days. Carotene values in the blood plasma of these calves showed a range of 25 to 100 micrograms per 100 cc. of blood plasma. These values, in general, increased during succeeding six month periods. When blood plasma values at ages between 18 and 24 months dropped below 150 micrograms, difficulties were often encountered at the time of parturition or at the beginning of the lactation period, even though these animals had attained normal body weights and were in good physical condition.

THE EFFECT OF SHARK LIVER OIL FEEDING UPON MILK PRODUCTION AND BLOOD VITAMIN A. I. W. Rupel, Paul D. Boyer, and Paul H. Phillips, *University of Wisconsin.*

The feeding of shark liver oil to milch cows in the late and heavy production periods of lactation has been studied to determine the effect on milk yield and the vitamin A content of the blood. The daily feeding of 25 c.c. of shark liver oil with a vitamin A potency of 7,500 and 15,000 I.U. per gram was studied in a group of 7 Holstein and Guernsey cows. This amount of oil caused no effect on the milk flavor, the amount of milk produced, or the per cent of fat in the milk during a 6-week period. A second experiment was made using cows just past the peak of their milk flow. These cows were each given 90 c.c. of a 15,000 I.U. shark liver oil daily for 8 weeks. The data indicate no effect on the flavor of the milk, however, a noticeable drop in the amount of 4 per cent fat-corrected milk produced was obtained with the beginning of the shark liver oil feeding. A manifold increase in the blood vitamin A resulted from feeding the shark liver oil. These data do not confirm the work of Deuel et al., who claim that shark liver oil feeding induced greater production of both milk and fat.

Swine Section

E. H. Hughes, *chairman*

ORGANIZATION AND DEVELOPMENT OF THE REGIONAL SWINE BREEDING LABORATORY. W. A. Craft, *United States Department of Agriculture.*

The Laboratory located at Ames, Iowa, was established in 1937 as a cooperative undertaking involving the U. S. Department of Agriculture and State experiment stations of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio,

Oklahoma, South Dakota, and Wisconsin. Representatives of the cooperating agencies formulated the program of research initiated and participate in an annual conference for the purpose of reviewing the progress accomplished and revising the approaches.

The objective of the Laboratory is to explore experimentally the problem of improving swine through the application of breeding methods. The problem is essentially twofold. (1) heritable improvement in economy of production which is of economic concern to the producer, and (2) heritable improvement in the merit of hog carcasses which is of particular interest to the consumer and of general interest to the producers to the extent that such improvement may be reflected in prices paid for market hogs and in volume of pork and pork products consumed.

Seven of the State experiment stations are participating actively on a cooperative basis; these are Illinois, Indiana, Iowa, Minnesota, Missouri, Nebraska, and Oklahoma. The work is coordinated by a director.

The objective is being approached through four phases of study: (1) systems of breeding, (2) development of procedures which may improve the effectiveness of selection of breeding animals, (3) inheritance of economic characters, and (4) physiology of reproduction.

The first phase initiated, that of developing inbred lines within established pure breeds and from crossbred foundations, is well advanced. Inbred lines include 23 lines of Poland China, 10 lines of Duroc-Jersey, 3 lines of Hampshire, 1 line of Chester White, 1 line of Danish Landrace, and 2 lines from crossbred foundations. Inbreeding in some of the lines has advanced to a point so that a second step, that of converging inbred lines and testing their usefulness in commercial pork production, can be taken soon.

Research in progress should be considered at this time from two points of view: (1) the development of inbred lines which when used systematically by breeders and farmers may result in specific improvement of non-inbred stock, and (2) the development of procedures in breeding which may be used by breeders and producers themselves in improving the effectiveness of their efforts in swine breeding. Results and tentative conclusions are being reported from time to time as the project leaders believe their data justify.

A STUDY OF CERTAIN TRENDS IN INBRED LINES OF SWINE. Marvel L. Baker and Cletus F. Reinmiller, *Nebraska Agricultural Experiment Station.*

The Nebraska Agricultural Station in cooperation with the Regional Swine Breeding Laboratory is carrying five one-sire lines of Duroc-Jersey swine at the North Platte Substation. From the spring of 1937 to the spring of 1941, 330 litters were farrowed in four of these lines. In this period the weighted average inbreeding of the sires of these litters increased by seasons from 0 to 23 per cent, that of the dams from 0 to 23 per cent, and that of the litters from 7 to 30 per cent.

Based upon the regression upon season, when corrected for age of dam, the data did not indicate any definite trend for the nine seasons in the number of pigs farrowed, the number of pigs farrowed alive, number of pigs weaned, weaning weight of litter, or the productivity index of dam.

For the eight seasons, spring of 1937 to the fall of 1940, 182 test litters comprising a total of 765 pigs from the four lines were fed. These litters averaged, by seasons, from 6 to 27 per cent inbreeding. Body measurements as used in the Regional Swine Breeding Laboratory and taken upon the 765 pigs at a weight of approximately 225 pounds, did not indicate any definite trend toward change in length of body, width of body, depth of body or length of foreleg.

The feed requirement per unit of gain showed a slight but insignificant tendency to decrease, judged by the regression of feed requirement upon season. The regression of 180-day-weight on season was positive and highly significant.

The data considered do not indicate any marked deterioration in the four lines of inbred swine from which they were taken.

CONSTRUCTING SELECTION INDEXES TO MAKE MAXIMUM PROGRESS. L. N. Hazel and Jay L. Lush, *Iowa State College.*

A method of constructing indexes was developed by using multiple regression technique.

The index I intended to weight each of several characters so as to make the maximum net genetic improvement in economic merit if selections are based on that index. The heritability and relative economic importance of the different characters and the various correlations between them are the information necessary for making sure that each character in the index is given the proper amount of attention. An index was constructed from data taken on the Iowa station project of the Regional Swine Breeding Laboratory swine herd and its application tested on a later generation of pigs. The index is.

$$I = .136W - .296S + .160P$$

where W (180-day weight in pounds), S (score in points), and P (productivity of the dam) are used as measures of the rate of growth, market desirability, and ability to farrow and rear large litters, respectively, for pigs from seven to nine months of age. The average genetic gains expected per generation by selecting the half of the pigs which have the highest indexes are 7.1 pounds in 180-day weight, 0.2 point in score, and 0.2 point in productivity. The mistakes in selection caused by unmeasurable environmental factors, dominance and gene interaction make the index only 38.5 per cent as efficient as if the exact genotypes of each animal were known. When the average weight and score of litter mates can be included in the index its efficiency increases to 40.4 per cent. Indexes should be constructed and their application tested on several different experimental herds in order to make certain of their general applicability.

HERITABILITY OF DIFFERENCES IN 180-DAY WEIGHT AND MARKET SCORE OF DUROC SWINE. J. A. Whatley, Jr. and R. H. Nelson, *Oklahoma Agricultural Experiment Station cooperating with the Regional Swine Breeding Laboratory.*

Half-sib correlations and offspring-parent regression coefficients were used to determine the heritability of 180-day weight and score at a market weight near 225 pounds. The close relationship between the two traits was shown by a positive correlation of $.639 \pm .011$. The data included 193 litters of 1067 pigs from four inbred lines and crosses between these lines. The inbreeding of the pigs averaged 9 per cent and ranged from 0 to 52 per cent. It was necessary to apply seasonal correction factors to the data because of the wide differences between the six farrowing seasons (1938 Spring through 1940 Fall).

The following correlations between weights of sibs were deduced from analysis of variance tables: .107 for paternal half-sibs, .146 for maternal half-sibs, and .380 for litter mates. Corresponding correlations between the scores of sibs were: .067 for paternal half-sibs, .094 for maternal half-sibs, and .345 for litter mates.

The intra-sire regressions of offspring on dam were $-.159$ for weight and $+.068$ for score. The intra-dam regressions of offspring on sire were $+.111$ and $+.272$ for weight and score respectively.

Combining the results from the half-sib correlation and the offspring-parent regression coefficients indicated that 23 per cent of the individual differences in 180-day weight and 33 per cent of the individual differences in market score were hereditary.

THE EFFECT OF SEX ON THE DEVELOPMENT OF THE PIG. I. DIFFERENCES IN GROWTH (RATE AND BODY MEASUREMENTS) BETWEEN BOARS AND BARROWS BY LINES OF BREEDING. L. M. Winters, R. E. Comstock, D. F. Jordan and O. M. Kiser, *University of Minnesota*

In the Minnesota project of the Regional Swine Breeding Laboratory, eight inbred lines of the Poland China breed and one line (Minn. No. 1) from a crossbred foundation are in the process of development. Observation indicated that the boars of the Minn. No. 1 line came into sexual maturity at an earlier age than the Poland China boars and as a result deviated more from the pattern of their barrow brothers than the Poland China boars. Observation also indicated differences between Poland China boars in this respect. It therefore appeared that the appearance of a boar in some instances may be a misleading indication of what he would look like had he been a barrow.

In order to study the problem, litter brother boar-barrow pairs were made and measurements of growth taken regularly. The measurements taken were: I, body length; II, heart girth; III, flank girth; IV, chest depth; V, width back of shoulders; VI, width of loin; VII, height even with forelegs; and VIII, weight. The study consists of 36 Poland China pairs and 7 Minn. No. 1 pairs taken in 1940 and 32 Poland China pairs and 12 Minn. No. 1 pairs taken in 1941. The results taken by years are almost identical. Boars of the Minn. No. 1 line outgained their barrow brothers in all respects excepting flank girth through the 12th week; then the barrows began taking the lead. The Poland China boars retained the advantage over their barrow brothers throughout the entire period although their advantage in weight was not significant after 16 weeks.

THE CALCIUM AND PHOSPHORUS RELATIONSHIP IN RATIONS OF GROWING AND FATTENING PIGS. G. Bohstedt, J. M. Fargo, W. A. King and O. B. Ross, *University of Wisconsin.*

In a series of experiments with pigs on pasture and in dry-lot, the latter having concrete outdoor runs, the calcium: phosphorus ratio of approximately 1.25:1 in the grain mixture was found most efficient. This ratio represents the addition of 0.65 per cent high-calcium ground limestone to the basal ration of ground yellow corn, expeller soybean oil meal, and 0.5 per cent salt, with 5 per cent ground alfalfa hay fed only in dry-lot.

Ground limestone was fed in amounts varying from 2.00 per cent to 0.25 per cent of the ration, representing a Ca:P range of 2.9:1 to 0.8:1. This resulted in levels of 0.88 to 0.23 per cent elemental calcium and 0.31 per cent elemental phosphorus in the ration. The use of phosphorus by way of steamed bone meal in partial or complete substitution of calcium carbonate in most cases made for more rapid and economical growth, also better calcification of bone.

The response of pigs on alfalfa and rape pasture was, with reference to the most favorable amounts of mineral supplements, comparable to that of pigs in dry-lot.

Limited work with pigs that were kept away from direct sunlight showed that either 5 per cent ground alfalfa hay or 0.65 per cent ground limestone, or both, proved insufficient to prevent rickets.

DIFFERENCES IN MOTHERING AND NURSING ABILITY OF SOWS AS A CAUSE OF DIFFERENCES IN SOME WEIGHTS OF THEIR PIGS. H. O. Hetzer, *United States Department of Agriculture.*

Data were analyzed to determine what fractions of the variance in the birth weights, 21-day, 56-day, 98-day, 140-day, and 182-day weights of 80 Chester White and 136 Landrace pigs farrowed at the Beltsville Research Center during the years 1939 and 1940 were due to permanent differences in the mothering and nursing ability of their dams. The 216 pigs included for study were in 54 litters out of 32 sows and by 17 boars. Each litter consisted of 4 pigs (generally two gilts and two barrows) chosen at random immediately after they were weaned at 56 days and all pigs were fed out in Record-of-Performance trials under standardized environmental conditions. The average weights of the pigs at birth, 21, 56, 98, 140 and 182 days were 3.1, 10.4, 29.0, 65.1, 118.9, and 183.2 pounds respectively. The correlations between paternal half-sibs, as deduced from analysis of variance were +.040 for birth weight, +.025 for 21-day weight, −.012 for 56-day weight, +.083 for 98-day weight, +.098 for 140-day weight, and +.060 for 182-day weight. The corresponding correlations between maternal half-sibs were +.183, +.236, +.356, +.313, +.284, and +.195. These correlations and the conditions under which they were obtained yielded values of 14.3, 21.1, 36.8, 23.0, 18.6, and 13.5 per cent for the portions of variance due to permanent individual differences in the ability of the sows to be good mothers and nurses. These figures are subject to large sampling errors, but indicate rather clearly that the part played by permanent individual peculiarities in mothering and nursing ability tended to increase up to weaning after which it tended to decrease with increasing age of the pigs.

A STUDY OF THE VALUE OF INCUBATED EGGS AND METHODS OF FEEDING THEM TO GROWING AND FATTENING PIGS. J. P. Willman, C. M. McCay, O. N. Salmon and J. L. Krider, *Cornell University.*

Digestion trials were conducted to determine the value of cooked versus raw incubated eggs for growing pigs. Two littermate fall farrowed pigs which weighed 64.5 and 61.0 pounds respectively at the beginning of the first collection period were used. Each of the three collection periods were of six days duration and each was preceded by a preliminary collection period of at least four days duration.

Equal weights of incubated eggs and ground yellow corn were fed in each trial. Salt was added to the corn at the rate of 0.3 pound for each one hundred pounds of corn.

The eggs used in the first trial were those that failed to hatch after 21 days of incubation. Only the infertile eggs were used during the second and third trials.

The results of the chemical studies indicate definitely that the fat and protein was as efficiently utilized by the pigs in the raw eggs as in the cooked eggs. Eighty-nine per cent of the protein in the ration of corn and eggs (incubator run) was digested for both raw and cooked eggs. In the same trials 86 per cent of the fat was digested.

In similar trials in which rations of corn and raw or cooked infertile eggs were fed essentially the same digestion values were obtained.

These data indicate that the pig is a unique species in its ability to utilize raw eggs and suggest that swine can derive biotin from this source.

THE PROTEIN REQUIREMENT OF LACTATING SOWS, PART I. S. H. Work, L. A. Henke and L. E. Harris, *University of Hawaii.*

Rations made up of corn meal, standard middlings, crushed oats, soybean-meal and fish-meal along with Leucaena glauca, a legume similar in feeding value to alfalfa, have been fed to lactating sows over a two-year period.

One mixture of these feeds contained 10 per cent and another 14 per cent total protein. Each has been fed to 10 nursing sows in alternate lactations, at the same rate, in accordance with good swine feeding practice. The estimated total digestible nutrients in the mixtures has not been less than 76 per cent. All animals have been confined in pens with outside cement runs.

On the ration containing 14 per cent total protein (by analysis), the 8-week weaning weights have averaged 34.6 pounds per pig. When the same sows have suckled pigs on the 10-per cent protein mixture, the weaning weight was 23.1 pounds per pig. The average weaning weight of all pigs in the station herd during this time has been 30 pounds. All pigs have been fed the same creep mixtures.

Once each week until weaning, the daily milk production of two sows was obtained. (This study is being continued.) Production was highest in the 4th week, being 6.7 for the low, and 7.9 pounds for the high protein sow during a 24 hour period. Lowest production was in the 8th week when 2.4 and 2.5 pounds were produced.

All sows fed the low-protein ration have lost more weight (25 pounds), with the decrease in weight being most marked in the first few weeks following farrowing.

Animal Industries Section

F. M. Simpson, *chairman*

POSSIBILITIES OF NEW DEVELOPMENTS AND UTILIZATION OF BY-PRODUCTS. V. Conquest, *Armour and Co.*

Competing products of various kinds and substitutes for many processed by-products call attention to the need for newer and more profitable products and processes to replace those now being threatened. Some of the newer developments announced within the last several years may be taken as an indication that research is being carried on now that will furnish some of the needed results.

The first necessity is for much analytical research so that the chemists and others working on the problems of better utilization of by-products may have the fundamental chemical,

physical and biological information needed for an intelligent appraisal of the various possibilities. On the meager information of a basic character at hand we can foresee some of the trends.

Proteins as a class are the most complex by-products and include substances having a diversity of chemical constitution and physical characteristics, such as blood, collagen, hair and hoof. From some proteins we will see new enzymes, hormones, surface active materials of many uses, better textiles, new compounds of as yet unknown uses utilizing the peptid and amino structures as building blocks.

Fats with their long carbon chain and carboxyl groups seem to have greater possibilities for a variety of new compounds than even coal tar products. Chemical technology of the future will demand larger and larger molecules, and proteins and fats offer a fine opportunity to build such large molecules in suitable orientation.

The job is too big for the packing industry to do alone and much help must come from all those working in agricultural, university, governmental and industrial laboratories.

HISTORICAL REVIEW OF BY-PRODUCT UTILIZATION. John H. Noble, *Armour and Company.*

By-products of livestock have been used in some degree for at least 5,000 years. Hides and skins, for example, are mentioned in some of the most ancient records. Wool was likewise used while man was still in the primitive hunting stage. Most of the progress in by-product utilization, however, has come about during the last half century and is associated with the growth of meat packing as a large scale industry. When livestock was dressed by local butchers, the concentration of volume of many by-products was too small for their scientific utilization.

Pressure to find greater use for by-products first developed from the problem of disposing of viscera, heads, feet, and similar products having no value as meat. As recently as 1875 vast quantities of hog-heads were buried. Since then the meat packing industry has come to utilize by-products completely to eliminate waste. Consequently, farmers have received better prices while consumers have enjoyed the advantages of new and improved products.

The first full time chemist was employed in the packing industry in 1884. Soap, oleomargarine, and shortening compound were manufactured previously. Use of tankage as an animal feed supplement was not developed until 1900. Production of meat scraps by the dry rendering process was not perfected until 1924. Most of the growth in the pharmaceutical field has come about since 1900, with the greatest diversity in products since 1920.

Utilization of livestock by-products not only makes possible the satisfaction of many human wants, but likewise relieves untold human suffering from various diseases. The use of liver extract in combating pernicious anemia; of mucin in treating stomach and duodenal ulcers; of insulin in diabetes; of epinephrine for relieving asthma, hay fever and hives; and the recent developments in the use of thyroid and other hormones to supply glandular deficiencies in children and adults are some of the outstanding contributions of by-product utilization to the welfare of society.

APPLICATION OF BY-PRODUCTS TO LIVESTOCK PRICES. P. C. Smith, *Swift & Company.*

Livestock prices are controlled by supply and demand. Occasionally, we find people who are inclined to discount these factors. However, economic laws have a way of keeping fundamental truths before us.

The packer buyer buys cattle, lambs, and calves based on the graded cost of the meat these animals produce. In converting the graded cost to a live price, or bid, one of the important things to consider is the value of the by-products. The packer in considering the by-product values uses the current market even though his minimum possible stock will be about a four weeks' supply. With around a four weeks' supply of by-products on hand at all times the packer does—on advancing markets—make inventory profits, but, by the same token, he takes corresponding losses on declining markets.

Supply and demand are the determining factors making by-product markets. Supply being the determining factor as, barring unusual conditions, the demand remains about constant. With increased supply, the market naturally weakens and on this declining market the seller

is naturally behind the market and does not obtain the full market price for the total quantity he has on hand. When there is a decreased supply the market advances, and even though the seller does realize the full market value he gets this on a lessened quantity. This results in selling the largest quantity at somewhat under the market and therefore the average realization price over a period of time will be somewhat under the quoted market for by-products. When an increased price can be secured for meat and/or by-products, prices of livestock go up. When the value of meat and/or by-products goes down it naturally follows that the price paid for livestock must be adjusted accordingly.

THE ECONOMIC SIGNIFICANCE OF BY-PRODUCTS. G. B. Thorne, *Wilson & Co.*

By-product utilization in the meat packing industry has expanded to a position of great economic importance to the producer and the processor. The Census of Manufacturers shows that in 1939 the wholesale value of livestock by-products in raw material form was $250,000,000, which represented approximately 13% of the total value of all products produced in the meat packing industry during that year. Census data for 1941 are expected to show a further increase.

The packing industry was one of the first to demonstrate increased efficiency through mass production. More efficient by-product utilization has contributed substantially to the success of its large-scale operations. Many by-products are found in individual animals in extremely small amounts. Approximately 10,000 cattle are required to produce one pound of a pituitary gland extraction in powdered form, and it is only through large-scale operations that it is practical to produce this product.

The packer has become increasingly conscious of the economic loss resulting from the substantial percentage of by-products unfit for use. Many of these losses are traceable to production and marketing methods, and their reduction presents a challenge to improve financial returns to the livestock industry. One out of ten beef livers, for example, is condemned as unfit for food—a loss to the industry during the year ending June 30, 1940, of approximately $2,000,000. Parasites are responsible for a heavy loss from condemned pork and lamb livers, as well as for lowering the monetary value of sheep, beef and hog casings. Other examples of preventable losses in the value of by-products are hides damaged by cattle grubs, sheep and hog lungs damaged by parasites and sheep pelts greatly reduced in value because of burrs, taglocks and other avoidable conditions.

COMPETITION OF NEW SYNTHETIC MATERIALS FOR PACKINGHOUSE BY-PRODUCTS. H. H. Young, *Swift & Company.*

In many cases markets for by-products have been based not upon any value inherently present in the by-products themselves, but rather upon their chemical composition such as protein or nitrogen, and depending upon their ultimate use as fertilizers or animal feeds. Such is the case at least until it is found profitable to divert their use into other channels. Much the same thing can be said for fats and oils.

Laboratory Research in the Meat Packing Industry has had as its goal the improvement of these relatively low values. This has been effected by a specialization of by-products whereby they have been tailored to fit definite uses, many of which have been new. Some competition was existent when the newly developed by-product entered the field, whereas other competitors sprang up almost immediately to challenge any unique position the by-product might have enjoyed. This has now resolved into a vigorous but healthy competitive activity featured by a constant flow of new developments from our Laboratories which have had to hold their own with all competitors. Our study indicates that the Meat Packing Industry has the advantage since it already has an outlet for by-products at a definite value, and any enhancement of value becomes distributed so that the live-stock raiser, meat packer, and consumer are benefited. Another advantage is that our raw materials are fresh, of reasonably constant volume concentrated in one place, and are made up of valuable compounds, which are not available from any other commercial source.

These compounds are waiting to be fabricated into new and useful materials. Such new products will have to compete with synthetic alternates, but it is improbable their actual syn-

thesis will ever be effected so as to compete with our present supply of raw materials. Examples of these advantages may be found in the development of a pure gelatin, and pure fatty acids, competitors of which have either defied synthesis or have been produced only at high cost.

Pharmaceuticals derived from animal sources have, at this writing, no competitors. Even the recent synthesis of certain vitamins has failed to affect the more pleasant way of balancing the diet by a wise selection of wholesome natural foods.

Teaching Section

R. T. Clark, *chairman*

PLANNING COURSES TO MEET STUDENT NEEDS. H. M. Byram, *Michigan State College.* (No abstract available)

SOME PHASES OF FRESHMAN INSTRUCTION IN ANIMAL HUSBANDRY. M. A. McCarty, *Pennsylvania State College.* (No abstract available)

A DIRECT METHOD OF COMPUTING RATIONS. Burch H. Schneider, *West Virginia University.*

A direct method of computing livestock rations is advanced which gives the exact answer, and requires no trial ration or jockeying of figures to fit the feeding standards. Instead of the familiar nutritive ratio, it is necessary to use a value, the percentage of digestible protein in the T. D. N. The Pearson square, commonly used in standardizing cream, is employed and the pounds of T. D. N. from each of two feeds or groups of feeds is computed. From the pounds of T. D. N. from each source, the pounds of each feed or group of feeds can be calculated. An example ration for a fattening, growing pig is computed, using trio mixture and corn.

This method has proven useful in teaching students who desire a direct method of computing rations instead of the usual trial-and-error method. The method has been found helpful in grading students' papers by using it to compute the extreme amounts of feeds possible within the feeding standards. Also, it can be used to compute exact experimental rations.

FIELD TRIPS AS A PART OF ANIMAL HUSBANDRY INSTRUCTION. W. L. Stangel, *Texas Technological College.* (No abstract available)

Extension Section

W. B. Connell, *chairman*

AN EXTENSION LIVESTOCK PROGRAM IN COLORADO. A. C. Allen, *Colorado State College.*

Two Hereford Tours have been held in the state with about 300 attending each time for a period of three days.

These Tours, in both instances, were held for the purpose of acquainting different breeders with the methods, stock and management of their fellow breeders, and to create a better fellowship within the fraternity. Conclusions were drawn that it has brought about a much better feeling. In many instances men have changed their management practices, and it has been the means of selling nearly $100,000 worth of breeding stock that might or might not have been sold otherwise. Certainly it did, in many instances, put stock in the hands of some breeders where they would not otherwise have gone.

From the start of working with a committee from one association in buying bulls, and getting them to buy bulls in groups, this practice has been spread to where some fifteen associations are cooperating in this work at the present time.

Grading cow herds has been carried on in various sections of the state, and has reached the point where the stockmen are systematically following this practice each year.

Culling and grading demonstrations are given in the culling of ewes for wool type, body type, and confirmation, and as a result this work is largely carrying itself at the present time.

Wool grading demonstrations are carried throughout the state. In the spring of the year wool samples are taken and submitted to the laboratory where they are scoured and results returned to the grower. Twenty-five demonstrations were given this year and wool samples from seventy-two flocks were scoured at the College Laboratory. As the result of this grading work in previous years, a Wool Laboratory, equipped in an up-to-date manner, was established at the insistence of the wool growers in the state, and a wool department is now in the curriculum.

OUR EXTENSION PROGRAM FOR THE RANGE LIVESTOCK INDUSTRY. G. W. Barnes, *A. & M. College of Texas.* (No abstract available)

THE USE OF VISUAL AID IN ANIMAL HUSBANDRY. L.K. Bear, *Ohio State University.*

Most substitutes for the spoken or written word serve as visual aids in teaching. Extension workers have used various devices to carry their information to the understanding of stockmen and farmers. Specimens, models, diagrams, charts and pictures have been used effectively. Their use is not new but they have been employed more widely in recent years.

There is probably no one best among the various devices. Adaptability varies with the situation surrounding the use and the character of the subject matter. Many workers use most effectively the illustrative material prepared by themselves. Extension men seem to be better amateur photographers than model building craftsmen or painters. This accounts in part for the popularity of projected pictures.

An exhibit of some material is valuable at a meeting place. The audience is prepared for the material to be presented. Models, specimens and photographic prints have a place before and after the meeting. Motion pictures have a drawing power, yet their excellence as an aid in teaching is limited to action. Still slides have enjoyed a fast growing popularity because of low cost and convenience. Projected pictures cement attention. Specimens and other "pass arounds" temporarily remove a part of the listening audience. They have their greatest value in exhibits displayed before and after the session.

Visual aids are Extension workers' tools, just as are the demonstration, the tour, and the circular letter. Like the tools of any successful worksman, they must be adapted to the job and kept in working condition.

ONE-HUNDRED POUND LAMB CREDIT PER ONE-HUNDRED POUND EWE WEIGHT. E. L. Benton, *Michigan.* (No abstract available)

INTEGRATING ANIMAL HUSBANDRY INTO THE GENERAL AGRICULTURAL PROGRAM. J. W. Burch, *University of Missouri.*

For twenty-five years the Agricultural Extension Service has moved forward through use of demonstrations of individual enterprises. On one farm we demonstrated the growth of alfalfa; on another, how to raise healthy pigs. We have tended in many instances to develop lopsided farming systems. We have all seen cases where even a master farmer in beef production went broke because he did not provide proper pasture or did not know how to raise the feed for his cattle and had to buy so much that he finally failed.

It appears that the time has come when the specialist should assist county agents and farmers in developing a well-rounded plan for the individual farm. We are starting what we call the "Balanced Farming Program." This is based upon the idea that every farm should have the right kind of crop rotations, proper soil treatments and water disposal, a well-planned livestock system fitted to the land and to the operator with an accurate set of records to tie the thing together. The farmer must do this planning himself. Experience indicates that where someone else does the planning for him, he does not understand it well enough and believe in it enough to see that it is actually carried out and make the adjustments in it that will be necessary because of changing conditions under which he must operate.

This program was started by a three-day Balanced Farm Planning School out on a farm for the animal husbandry, dairy, crops, soils, soil conservation, agricultural engineering and

farm management specialists. Specialists were divided into teams and each team planned the farm. Specialists were again divided into teams to give county agents a three-day training school on the farm. The agents will train the chairmen of neighborhood groups who wish to undertake this program. These groups of perhaps six or eight farmers and their wives will meet during the fall and winter, plan their own farms, with full discussion as to methods and practices. The county agent will assist the chairman with his first meeting. As special problems develop upon which the planning group may wish assistance, the county agent may meet on the farm with them, or may ask for the assistance of the specialist in working out the solution.

It will mean something when we can say, "There are one hundred men in this county who really have a sound farming system that has as a part of it a well-balanced livestock system." Such a program will take years of work and a tremendous amount of patience and cooperation on the part of the specialists involved, but we believe it is worthwhile and that the time has come when it must be started.

FOOD FOR DEFENSE. Grover B. Hill, *Assistant Secretary of Agriculture.*

On the shoulders of the American men and American women engaged in agriculture today rests the responsibility of feeding not only the people of our own nation, but the people of all other nations now fighting to keep the world free. We are fortunate that we are better prepared today to do that work than ever before.

We have a better knowledge of farming and methods of financing it. We know more about fighting plant diseases and insects, about fighting droughts by contour-farming methods and drought-resisting plants. We have the best cattle, hogs, sheep, and poultry ever owned by farmers of any nation at any time.

We have built up through our farm programs a great democratic system through which our farmers can turn quickly and effectively to the tasks the war asks of them. American agriculture is called on to produce in 1942 the biggest output of certain farm products in our history. This means an adjustment downward in some lines, such as wheat and cotton; upward in others, such as pork, fruit, milk, eggs, and certain vegetables.

The nations aligned with us to stamp out the plague of Nazism look to us for more of these products which they have not the time nor resources to produce—supplies which mean the very lives of their armies and their people.

Planes and tanks and guns are moving from our production lines. Food must continue to move from the production lines as well. America has become the food arsenal of the world. No nation was ever before called on to feed so many people. It is a tremendous job, but we are capable and ready, and we will get the job done.

THE PLACE OF 4-H PIG CLUB WORK IN OUR ANIMAL HUSBANDRY EXTENSION PROGRAM. L. C. Madison, *Pennsylvania State College.*

A survey of leading swine producing States brought out the fact that although considerable information is distributed to Club members in regard to care, feeding, and management, little or no consideration is given to these factors in determining the final score. In most clubs the placing of the pig in the ring at the club round-up determines the score of the Club member. This method places too much emphasis upon the individuality of the pig and too little upon what the member has learned or how conscientiously the instructions have been carried out. As judging is not an exact science, basing the score upon the placing of the pig, according to show ring standards often caused criticism, disappointment, and resentment.

To overcome some of the objectionable features and place more emphasis on the lessons that should be taught, a new score card was devised emphasizing good management. In this card the score for the individuality of the animal is minimized and placed on a merit basis.

Each year for the first three years the management score card was changed to increase the emphasis on those things which the members had a tendency to neglect. As finally adopted, it seems to meet our conditions.

The success of the new card is indicated by the fact that in five years' time there was an increase in enrollment and number of clubs of over six hundred per cent, as well as a very noticeable improvement in the quality of the work.

FITTING LIVESTOCK INTO THE FAMILY FOOD SUPPLY PROGRAM. K. F. Warner, *United States Department of Agriculture.*

Over 8,000 pounds of food are required to provide a moderately adequate annual diet for a farm family of five. Amounts for individual members will vary from about 1300 pounds for a five-year old girl to around a ton each for father and the hard working older boys. A great variety of foods must be contained in these four tons if adequate nutrition is to be obtained. A rough estimate of the weights of each class of foods is given by the Bureau of Home Economics: Milk—1,525 quarts, Butter—125 lbs., Other fats—175 lbs., Lean meat, poultry, and fish—675 lbs., Eggs—125 dozen, Dried beans, etc.—65 lbs., Tomatoes and citrus fruits—500 lbs., Green or yellow vegetables—800 lbs., Potatoes—800 lbs., Flour and cereals—1,000 lbs., Other vegetables and fruits—1,000 lbs. and Sugar—300 lbs.

Obtaining this quantity and variety of food is the first lien on the farm and on the time of the family that operates it. We speak of "first mortgages." Such contracts are really fifth mortgages as income must first meet the demands for (1) food, (2) housing, clothing, etc., (3) operating expenses, and (4) taxes before even the interest on the loan can be met.

The home production of family needs for food, fuel, and repairs reduces the need for cash and releases income for things which the family cannot grow or make. This home production reduces expenses in the same manner that by-products reduce the net operating costs of the packing industry

Milk cows, a fed calf, two or three hogs, some chickens, a garden, and a berry patch increase this work at chore time, but they also increase the annual number of productive hours of family labor. Those livestock are also essential to utilize the forage, pasture, and silage needed in a diversified farming system that can be adjusted to meet the needs of the future.

Fitting livestock into a food supply program helps to keep both farm and farmers fit.

Conference on Artificial Insemination

F. N. Andrews, *chairman*

A STUDY OF ESTRUS AND OVULATION IN THE MARE. John N. Cummings, *Montana State College.*

Observations on estrus and ovulation were made on 16 mares at Montana State College, Bozeman, Monta during the winter and spring of 1940. Of the forty estrual periods studied, of which 14 were foaling estrual periods, five types of estrus were observed. In 21 cases regular estrus was observed; in six cases, estrus with post estrual ovulation; four cases, split estrus; three cases, silent estrus; and six cases, estrus without ovulation. The length of all estrual periods ranged from 0 to 10 days (av., 5.25). The length of the diestrual periods ranged from 8 to 28 days (av., 15.58). The length of the estrus cycles ranged from 12 to 30 days (av., 20.95). Ovulation occurred between 0 and 9 days after the onset of estrus (av., 4.68). The length of time that elapsed between ovulations in the same mare ranged from 12 to 29 days (av., 22.4). The length of the foaling estrual period ranged from 0 to 10 days (av., 5.71). Ovulation first occurred between 10 and 49 days after foaling (av., 17.8) and between 2 and 9 days after the onset of foaling estrus (av., 5.64). The number of days following foaling before the mares first showed signs of estrus ranged from 4 to 36 days (av., 11.31). However, one mare never did show psychological estrus after foaling during the course of the study. In most cases it was found that there was no tendency for the mares to follow the same general pattern in succeeding periods even though there were considerable differences between mares.

STAINING AFFINITY OF BOVINE SPERMATOZOA. Robert G. Fossland and Gravers K. L. Underbjerg, *University of Nebraska.*

As one approach to the elucidation of the reasons for the loss of fecundity of viable, motile, stored spermatozoa; staining of fresh and stored semen was tried to see if any morphological differences could be detected. If any differences could be readily noticed by such a method, it would be of help in evaluating semen quality. In following this premise a number of stains were used on semen samples which were stored up to 96 hours, and which were obtained from fertile bulls.

Using two suitable stains and by plotting the staining intensity according to an arbitrary range of staining intensities, against hours of storage statistics were computed on the data obtained. A regression coefficient of E equals 3.183625 minus 0.00223 X where E equals estimated staining intensity and X equals hours of storage was obtained. On this data, the standard error of estimate was 0.757. A test of significance applied, shows t equals 0.957 which is far below the 1 per cent level of significance. The correlation (Pearson r) showed r equals minus 0.09084.

Apparently there is no relation between staining intensity and length of storage under the conditions of the experiment, although all samples did not possess the same affinity for stain. The staining intensity of fresh samples extended over the entire range of an arbitrary range of staining intensities; the same holding true for the other storage periods.

It was also noted that atypical forms of spermatozoa were present on all slides, from all bulls, and from all ejaculates, indicating that this is a normal occurrence.

Acknowledgement is made of a grant in aid for this study by the American Dairy Cattle Club.

A PRELIMINARY REPORT ON THE EFFECT OF THE RATION ON THE SEMEN PRODUCTION OF YOUNG DAIRY BULLS. Henry A. Lardy, Paul H. Phillips and I. W. Rupel, *University of Wisconsin.*

The effect of diet on the semen production of young growing bulls has been studied with the following results. Ejaculates from 3 bulls reared on a low Mn ration of corn, corn gluten, timothy hay, and minerals have shown small volume, low sperm count, poor sperm motility, and short storing period. In contrast, the ejaculates from 3 bulls receiving the same ration plus a supplement of $MnSO_4$ have been of normal volume, high sperm count, excellent motility, and the sperm maintained motility for a long storage period. Three bulls receiving a supplement of ground oats produced semen comparable to that produced by the bulls receiving the supplement of manganese. The administration of alpha tocopherol was without beneficial effect on the semen production.

These preliminary results indicate that an adequate amount of manganese is essential for sperm production in the dairy bull.

SOME FACTORS INFLUENCING THE RESISTANCE OF BULL SPERM TO UNFAVORABLE ENVIRONMENTAL CONDITIONS. John F. Lasley, G. T. Easley and Ralph Bogart, *University of Missouri and United States Department of Agriculture.*

A staining method (developed by Lasley, Easley and McKenzie; to appear in Anat. Record) in which dead sperm are stained while live ones are not was used in this study for evaluating semen.

Egg-yolk buffer increased the ability of the sperm to withstand cold shock (0°C. for 10 minutes) by an average of 400 per cent and increased storage time approximately 600 per cent over non-diluted semen.

Forty-three different semen samples were diluted with egg-yolk buffer and divided into 2 portions. One portion was stored at 10°C. for 144 hours while the other portion was used to determine the percentage of sperm alive after 10 minutes at 0°C. The percentage of live sperm after the storage period was directly associated with the resistance of the sperm to cold shock.

A study of a large number of semen samples collected from 3 different bulls throughout the breeding season and diluted with egg-yolk buffer showed that one bull consistently produced sperm which were more resistant to cold shock and remained alive for a longer period of time during storage than sperm produced by each of the other 2 bulls.

The results indicate that the resistance of sperm to cold shock (0°C. for 10 minutes) may be used as an index of the ability of the sperm to live when diluted with egg-yolk buffer and stored.

FERTILITY IN SHEEP AT HIGH ALTITUDES IN PERU. Fred F. McKenzie, *Utah State Agricultural College.*

Sheep are commonly maintained at altitudes of 12,000 to 16,000 feet in the Peruvian Andes Mountains. Fifty breeding rams were examined in some detail, and only 18 were found

to have reasonably good semen, thus supporting the contention of sheepmen that 7 rams must be run with each 100 ewes instead of 2, which is the more usual proportion used in other sheep-raising countries. Lambing percentages based on the number of ewes in the breeding flock range from 12 to 91 per cent. The high altitude is thought to be a factor affecting fertility. However, it is the opinion of this writer that seasonal rainfall affecting the amount of grazing available is a chief factor. Figures are available showing lambing percentages at high altitudes with various levels of feed intake.

EFFECT OF DILUTERS AND STORAGE UPON FECUNDITY OF BOVINE SEMEN. Gravers K. L. Underbjerg, H. P. Davis and R. E. Spangler, *University of Nebraska.*

Fresh semen samples were treated and used for inseminations as follows: I, no treatment (control); II, diluted with fresh egg yolk buffer; III, diluted with stored egg yolk buffer; IV, diluted with autoclaved milk. Other samples V, VI, VII and VIII receiving the same series of treatments respectively were stored prior to insemination. A total of 931 cows were inseminated in these eight groups of which 492 conceived. Conception percentages in the various groups were as follows: I, 63.5; II, 54.5; III, 42.9; IV, 46.5; V, 36.7; VI, 25.9; VII, 38.5; VIII, 30.8.

Chi-square values were obtained on the conception percentages using the control groups I and V as bases. The sum of the chi-square values for II, III and IV using 63.5 per cent as base, $X^2 = 9.9942$. For 3 df $P = 0.03$, which indicates that the treatments accorded the fresh semen tended to lower the conception percentage. Using one degree of freedom the individual value of X^2 of II was not significant, but in III and IV indicated a trend towards a significant difference. Thus the treatments with the stored egg yolk and the autoclaved milk indicate a slight reduction in fecundity. The sum of the chi-square values of V, VI, VII and VIII using 63.5 per cent as base, $X^2 = 122.9764$. For 4 df $P = <0.01$, which shows that storage caused a marked decrease in the conception percentage.

Using 36.7 per cent as base for the stored groups the sum of the chi-square values for VI, VII and VIII, $X^2 = 6.0546$. For 3 df $P = 13$, which envinces that the treatments did not cause a significant departure from the conception percentage of the untreated stored control group.

It is concluded that the treatments had little beneficial effect on fecundity, but that during storage other factors are in operation which cause loss of the fertilizing capacity of bovine spermatozoa.

Acknowledgment is made of a grant in aid for this study by the American Dairy Cattle Club.

A COMPARISON OF FIRST AND SECOND SEMEN COLLECTIONS FROM DAIRY BULLS. E. J. Weatherby, R. P. Reece and J. W. Bartlett, *New Jersey Agricultural Experiment Station.*

A common belief among dairymen has been that two natural services were more effective in settling a cow than one service. It was therefore of interest to compare first and second ejaculates when the second ejaculate was collected immediately after the first. 108 paired ejaculates were secured from three dairy bulls using the artificial vagina.

Sixty-one paired ejaculates were secured from a mature Jersey bull. The total volume from 61 first collections was 189.0 cc., compared with 331.6 cc. from an equal number of second collections, or an average of 3.1 cc. and 5.4 cc. respectively. Concentration was 985 million sperm per cc. for the first and 990 million for the second collections. Longevity for first and second collections was 9 and 10 days respectively.

Twenty-six paired ejaculates were secured from a mature Holstein-Friesian bull. Total volume for the first collection was 88.1 cc. (average sample 3.4 cc) as compared with 167.7 cc. (average sample 6.4 cc.) from the same number of second collections. Concentration average 907 million per cc. for first and 1,223 million per cc. for second collections. Longevity averaged 7 and 11 days for first and second collections respectively.

Twenty-one paired ejaculates were secured from a second mature Holstein-Friesian bull. Total volume, average volume, concentration, and longevity for first and second collections respectively were as follows: 77.8 cc.–144.7 cc.; 3.7 cc.–6.9 cc.; 1916 million per cc.–1527 million per cc.; and, 12 days–16 days.

This work was supported by a grant from the National Dairy Products Corporation, New York City.

Meats Section

L. E. Kunkle, *chairman*

QUALITY OF MEAT AS AFFECTED BY THE RATE OF FREEZING. D. E. Brady, Pauline Frei and C. W. Hickman, *University of Idaho.*

A study conducted on the relative merits of quick and slow frozen beef, pork and lamb steaks lends little support to the belief that quick freezing results in maintaining a more palatable product than slow freezing.

Paired steaks cut 0.6 of an inch in thickness and weighing 350 to 400 grams were double wrapped in 30 pound test double waxed paper and regular butcher paper. These steaks were frozen to an internal temperature of 0°F at room temperatures of −15°F and 0°F at rates of cooling of 5.3°F and 2.5°F per hour respectively. The steaks were stored 39 weeks at an average temperature and relative humidity of 6°F and 87 per cent respectively.

The evaporation loss was found to be 4.9, 7.0 and 9.8 per cent respectively for the quick frozen pork, lamb and beef and 5.5, 7.6 and 10.3 per cent for the slow frozen pork, lamb and beef respectively. One half of each the slow and quick frozen steaks were broiled while still frozen and the other half were thawed before broiling. Results show that the smallest total loss (drip and evaporation) occurred in the quick frozen steaks broiled while frozen and that the largest loss occurred in the slow frozen steaks, thawed before broiling. Losses for the steaks that were quick frozen and broiled thawed and for the steaks slow frozen but cooked frozen were intermediate in value and indicated that the type of broiling was not as important as the rate of freezing. Palatability scores reflect no significant preferance for either method of freezing or broiling.

INFLUENCE OF FREEZING UPON TENDERNESS IN AGED BEEF. Robert W. Bray, Gladys E. Vail and David L. Mackintosh, *Kansas Agricultural Experiment Station.*

Two studies were undertaken during the past year to obtain information about the influence of freezing upon aged beef and fresh pork.

The beef used in the study was obtained from six Hereford steers weighing about 700 pounds. The pork was obtained from good butcher hogs weighing about 250 pounds.

The experimental procedure for the beef study was similar to that used by Hankins and Hiner (1938) in their study primarily concerned with fresh beef. The procedure used in the pork study was similar to the beef study with modifications made where necessary.

The results of the study with beef indicate: 1. That freezing has no influence upon tenderness in beef that has been aged; however, indications were that this may vary among the animals. 2. Considerable variation in tenderness was found among the animals. 3. The posterior section of the short loin was found to be more tender than the anterior section. 4. The greatest variation existed among the cores taken from the longissimus dorsi muscle. 5. The right side was found significantly more tender than the left side, but as yet no satisfactory explanation can be offered for this finding.

The data from pork indicate: 1. That freezing does not influence the tenderness of pork; yet this may vary with the animal. 2. Considerable variation in tenderness was found among the animals. 3. A representative core sample was difficult to obtain from the roast nearest the posterior end of the loin. 4. The data did not indicate a progressive increase in the loin from anterior to the posterior end.

MEAT IN THE ARMY DIET. R. A. Isker, *Chicago Quartermaster Depot.* (No abstract available)

FEED AND MANAGEMENT PRACTICES IN RELATION TO COLOR IN BEEF. D. H. La Voi, *National Live Stock and Meat Board.*

The occurrence of dark-cutting beef in high quality cattle has baffled the industry for a number of years. The National Cooperative Meat Investigations group, various other groups

and individuals have made it a subject of study. In 1938 the Board was asked to coordinate the work of the groups interest in an effort to solve this problem. The studies conducted to date have taken into consideration the chemical, physiological and nutritional aspects of dark-cutting beef.

The 4-H Club calves shown at the International Live Stock Exposition offered an opportunity to study cattle on which breeding, feeding and management records had been kept. Consequently, they have been studied the past three years to prove and disprove many theories brought to the Board's attention as the cause of dark-cutting beef. A complete report on the carcass grading and color reading of the rib eye was sent to each 4-H exhibitor.

In addition other experiments with small animals, lambs and cattle have been carried on.

The data collected during the studies on 4-H Club cattle in 1938, 1939 and 1940 seem to indicate there is a predisposition to darkness of meat. It is worth noting that the trend has been to brighter cutting cattle each year. This may be due to improved feeding and management practices or better treatment (fed and housed) prior to slaughter.

Evidence gathered from experiments to date seems to indicate that abnormal feeding, exposure and improper handling tend to produce dark-cutting beef. Low muscle sugar and high pH have been found to be characteristic.

THE EFFECT OF DEGREE OF FATNESS ON TENDERNESS OF LAMB. C. E. Murphey, A. K. Mackey, J. C. Miller and S. Cover, *Texas Agricultural Experiment Station.*

One of the first considerations was that of developing a satisfactory technique for controlling as many of the variables that might affect the reliability of the results as possible.

In three separate tests involving a total of 130 lambs it was found that the production of various degrees of fatness by different methods of lot feeding of range lambs was not a satisfactory method of procedure even when the lambs were paired at the beginning of the experiment and the judgment of the tenderness of the cooked meat made by the paired-eating method. The judgment for tenderness by the weighted adjective system was found to be entirely unsuited for this study.

In individual feeding of twin lambs, or single lambs (paired as closely as possible) on limited and full fed rations to produce wide differences in degree of fatness and judging for tenderness by the paired-eating method approaches a satisfactory method. In two such tests involving eleven pairs of lambs no significant difference was noted; in fact 52 per cent of the judgments were in favor of the thin lambs even with a difference of 11.5 per cent and 8.6 per cent in separable fat in the carcass and leg respectively. If all 152 lambs were considered, a slight advantage might be indicated in favor of the fatter group; however, due to the fact that no uniformity of results between pairs was indicated, it does not seem that fatness in itself is of any value in estimating the tenderness of lamb.

Pasture Section

W. P. Garrigus, *chairman*

RECENT AGRONOMIC DEVELOPMENTS IN THE PASTURE FIELD OF INTEREST TO ANIMAL HUSBANDMEN. H. L. Ahlgren, *University of Wisconsin.*

Much recent agronomic research has been directed toward obtaining specific information of practical value applicable to pasture improvement. Considerable evidence is available in the humid eastern half of the United States in support of the conclusion that any program of pasture improvement must be based first on the application of such soil amendments as lime, phosphorous, potassium and nitrogen, when deficient.

Sustained productivity of pastures once the fertility requirements of the soil have been corrected, is largely dependent on grazing management. Growth in the spring is dependent on previously stored food reserves and all successive growth is dependent on foods synthesized in the leaves. It is essential, therefore, that forage be permitted to make sufficient growth at all times, if maximum productivity is to be attained.

Rainfall is one of the most important factors affecting the yield and chemical composition

of permanent pastures. Drought resisting legumes have been extensively used in rejuvenating permanent pastures in Wisconsin.

Permanent pastures in north central United States have been periodically ravaged by white grubs (Phyllophaga sp.). Recent research has shown that damage by this insect can be prevented by incorporating alfalfa, sweet clover and red clover in bluegrass sods without plowing.

The productivity and nutritive value of extensive areas classified as woodland pastures has been studied but not definitely ascertained.

Breeding improved strains of grasses and legumes for pasturage received little attention in the United States prior to 1935. It is known that maximum progress will be made only by breeding plants adapted to local conditions.

PROBLEMS OF RANGE LAND CONSERVATION AND USE. W. R. Chapline, *Forest Service, United States Department of Agriculture.*

Range lands, the uncultivated native forage producing lands, play an important part in the production of the nation's supply of livestock and livestock products and in the welfare of the rural population. Sound management of the extensive range areas of the West and the forest and other ranges of the South, the Ozarks, and other parts, is vital to sustained forage production and satisfactory and profitable production of livestock. Many problems, especially those now presented by the development of defense production and marketing goals, confront stockmen and administrators of public lands. Of outstanding importance, research to date has shown the necessity for abundant nutritions forage and better animals for most satisfactory production of livestock on range lands. This and other problems in turn point to a big job of education and extension, supported by facts and proven management principles and practices.

GRAIN VERSUS GRASS IN BEEF PRODUCTION. R. E. Hunt, *Virginia Agricultural Experiment Station.*

In 1937 the Virginia Agricultural Experiment Station in cooperation with the Bureaus of Animal Industry and Agricultural Economics of the United States Department of Agriculture, and the State Division of Markets at Richmond, Virginia, started an experiment to determine the relative value of beef produced from grass fed cattle as compared with that produced from grain fed cattle. This project was carried on over a period of over three years, using 40 head of 1,000 pound steers each year. The steers were of equal grade, quality, weight, age, and breeding. The winter feeding for both lots was the same but in the summer one half were fed grass and the other half were fed grain. The steers were fed so the two groups made the same average gains during the summer period.

As a result of these three years of experimental work we have drawn the following conclusions: 1. The value of the cattle produced will be the same whether fattened on grain or grass, if they were of equal quality and grade as feeders and have made the same gains, and were of equal fatness. 2. The grass fattened cattle shrank slightly more en route to market than did the grain fed cattle. 3. There was slightly more yellow coloring matter in the fat of the grass fattened cattle. 4. The dressing yields were the same for both groups. 5. In 1938 and 1939, packers paid $1.00 more per hundredweight for the grain fed cattle and in 1940 they paid 50 cents more per hundredweight. 6. Both groups of cattle produced the same grade of meat which sold at the same price level to the retail trade. 7. Either the grain fattened cattle sold too high or the grass fattened cattle sold too low.

INFLUENCE OF FERTILIZERS AND LIME ON THE PRODUCTION, PALATABILITY, AND NUTRITIVE VALUE OF PASTURE HERBAGE. R. H. Lush, *The National Fertilizer Association, Washington, D. C.*

The first American effort to measure fertility differences for pasture production was conducted in Rhode Island. The results which were published in 1900 showed that limed plots produced 2.5 times as much green material per acre as unlimed plots. But all fertilized, limed plots averaged four times as much green material as the unfertilized limed plots.

During the grazing seasons of 1929 and 1930 a total of 160 fertilizer tests on pastures were

conducted in 16 northeastern States. The results show that substantial increases in yield were obtained from the use of nitrogen, phosphoric acid, potash, and lime, with complete fertilizer and lime producing 2.5 times as much dry matter as untreated pastures. When 80 of these pastures were used in grazing tests, the completely fertilized pastures produced twice as much milk per acre as unfertilized pastures.

Rapidly growing plants are more palatable than slower growing ones. The addition of plant food to deficient soils stimulates more rapid growth and thereby increases palatability.

Results are now available to show that fertilizer treatment, and lime where necessary, will materially increase yield, palatability, and protein and mineral content of pastures, provided that poor moisture supply or poor physical condition of the soil are not limiting factors.

THE EFFECT OF INCREASED PASTURE AND ROUGHAGE ON LIVESTOCK PRODUCTION. C. W. McDonald, *Iowa State College.*

The soil conservation programs of the AAA and the Soil Conservation Service are resulting in an increased acreage of pasture and hay crops in Iowa. Efforts of the College Experiment Station and the Extension Service to improve the quality of these crops are increasing the yield of grass and roughage.

This increased supply is bringing the farmer face to face with the problem of adjusting his livestock program in order to find a satisfactory market for increased amounts of grass and roughage. The problem must be answered by each individual farmer on the basis of his resources of other feed, equipment, capital, and ability. There is no "rule of thumb" solution that can be applied to all farms. The solution may call for increases in certain kinds of livestock, or it may mean a complete shift in the grade of livestock handled and method of management. Some will no doubt use a combination of different kinds of livestock.

A number of Iowa farmers have already met and solved this problem on their farms. The more successful ones have found that these cheaper feeds can be marketed more profitably when used to help produce well-finished products such as milk, fat lambs and fat cattle, rather than feeder cattle or lambs. It is important to plan the production of these products so they will come on the market when prices are most favorable. The purpose of this paper is to discuss the problem of increased grass and roughage in general; and specifically, how some farmers are solving the problem.

Nutrition Section

P. B. Pearson, *chairman*

THE THIAMIN REQUIREMENTS OF PIGS AS RELATED TO THE FAT CONTENT OF THE DIET. N. R. Ellis and L. L. Madsen, *United States Department of Agriculture.*

The thiamin requirements of young pigs have been studied on three diets containing approximately 2, 11, and 28 per cent respectively of fat. Nursing pigs were taken from sows fed normal rations and placed on thiamin-deficient diets at the age of 21 days. As indicated by failure in appetite and cessation of growth, the animals on the low level of fat showed evidence of depletion at an average of 24 days, those on the medium level, 30 days, and those in the high level, 35 days.

Other symptoms noted were a gradual drop in body temperature and a weakening and slowing of the heart rate with the animals lapsing into a semi-moribund condition preceding death. The chief autopsy findings were extreme emaciation, flabby heart, congested liver, and occasionally free fluid in the abdominal, thoracic, and pericardial cavities.

Other animals given feedings of thiamin at different levels following the depletion period showed a prompt response in improved appetite, resumption of growth, and restoration of body temperature to normal. The growth response on the low fat diet supplemented with 40 micrograms of thiamin per kilogram body weight has been approximately the same as for pigs given 25 and 15 micrograms on the medium and high fat diets respectively. An allowance of approximately 135 micrograms of thiamin per 100 grams of carbohydrate and protein appears

to be the minimum amount to promote a growth rate of approximately one pound per day in pigs between ages of 6 and 14 weeks confined indoors in small pens. This allowance does not permit of appreciable storage of thiamin in the lean tissues such as the ham.

THE ROLE OF ANIMAL PRODUCTS IN THE NUTRITION OF THE SOLDIER. Paul E. Howe, *Sanitary Corps—The Surgeon General's Office, U. S. Army.*

Animal products serve two important functions in the soldier's dietary: (1) They are among the foods that contribute to morale through the flavor and interest they add to a meal; and (2) they are a major source of important nutrients. With regard to the latter, the following approximations of the percentage contribution of certain nutrients by animal products are obtained from the averages of food planned for various camps of the United States Army between May and September 1941: Energy—39.6 per cent, protein—60.1, fat—83.4, calcium—61.6, phosphorous—56.4, iron—49.6, vitamin A—40.5, vitamin B—54.3 (46.1), and vitamin G—73.0 per cent. These data do not include, except where indicated in parentheses, probable losses in nutrients through storage, preparation and service of food. Figures in parentheses refer to the percentages supplied on the assumption of fairly conservative losses in preparation. Food constituents obtained from meats, eggs, milk and milk products, butter and other fats are included in the figures given.

A study of amounts of animal products consumed per man per day during 1939–1940 indicates that the average member of the army consumes about 0.94 pound of meat and poultry per day.

THE MINIMUM REQUIREMENT OF PANTOTHENIC ACID FOR THE GROWING PIG. E. H. Hughes and N. R. Ittner, *University of California, Davis.*

It has been shown that pantothenic acid is necessary for normal growth and physical well being of the pig (Hughes in process of publication). By using a highly purified diet (sugar, casein, salt mixture, water and vitamins) and by feeding dl calcium pantothenate at various levels the minimum requirement of pantothenic acid for the growing pig has been determined. Calcium pantothenate (dl) was fed at levels equivalent to 0, 3.6, 7.8 and 11.8 mg. of pantothenic acid per 100 pounds of pig daily.

Using rate of growth and other symptoms of pantothenic acid deficiency as the criteria the minimum requirement of pantothenic acid lies between 7.8 and 11.8 mg. per 100 pounds of pig daily.

NUTRITIONAL DEFICIENCIES OF A CONCENTRATE MIXTURE COMPOSED OF CORN, TANKAGE, SOYBEAN OILMEAL, AND ALFALFA MEAL FOR GROWING PIGS. T. B. Keith, R. C. Miller, W. T. Thorp and M. A. McCarty, *Pennsylvania State College.*

In a series of studies on the nutrition of the growing pig, conducted during the past few years, a number of abnormal conditions—such as lameness, failure to grow, blindness, and crooked backs—has been encountered. The rations studied contained corn, tankage, soybean oilmeal, and ground alfalfa hay in varying quantities.

Leg stiffness was encountered in pigs of initial weights of 70 to 90 pounds when fed the above mixture with a high percentage of bonemeal and a low manganese content.

Pigs placed on test at an early age, with weights ranging from 20 to 35 pounds, failed to grow normally when fed the above mixtures. These pigs fed yeast or carotene with a mixture high in soybean oilmeal gained more rapidly than the pigs fed the mixture without yeast or carotene. Young pigs fed liver meal, with a mixture high in tankage and low in soybean oilmeal, gained more rapidly than pigs fed the same mixture without the liver meal.

SELENIUM POISONING IN LIVESTOCK AND MAN. A. L. Moxon, *South Dakota State College.* (Kodachrome movie)

A SCALE OF HEAT TOLERANCE FOR CATTLE. A. O. Rhoad, *United States Department of Agriculture, Jeanerette, La.*

At the Iberia Livestock Experiment Farm, Jeanerette, Louisiana, more than 150 cows,

heifers and steers have been tested for adaptability to tropical climatic conditions. As a result the variously bred types of cattle in the Jeanerette herds can be classified from the most adaptable to the least adaptable type.

Based on data obtained under conditions of a 'severe' test, i.e., cattle held in the sun with shade temperatures in the 90° F. class, and further based on deviation of body temperature from the normal, a convenient mathematical way of expressing the adaptability is discussed. This is represented in the formula for heat tolerance: $100 - 10[BT - 101.0]$, in which BT = body temperature obtained under conditions of a 'severe' test, 101.0 = normal body temperature for cattle, 10 = a factor to convert degrees deviation in body temperature from the normal to a unit basis, and 100 = perfect efficiency in maintaining body temperature at 101.0° F.

The heat tolerances for certain breeds and crossbred types have been determined and are as follows: Purebred Brahman 93, ½ Brahman ½ Angus 89, purebred Jersey 86, ⅜ Brahman ⅝ Angus 86, ½ Africander ½ Angus 83, purebred Santa Gertrudis 82, ¼ Brahman ¾ Angus 76, ¼ Africander ¾ Angus 75, grade Hereford 73, and purebred Aberdeen Angus 56.

These coefficients are approximate and tentative, especially in some of the cases based on small numbers of animals, but it is believed that the method serves a useful purpose in classifying variously bred cattle as to their capacity to withstand high thermal environments.

THE EFFECT OF A SIMPLIFIED DIET UPON REPRODUCTION AND LACTATION IN SWINE AND IN THE RAT. O. Burr Ross, Paul H. Phillips and G. Bohstedt, *University of Wisconsin.*

A ration used quite universally in the growing and fattening of swine was fed to young gilts and to rats with the object in mind to study reproductive processes. The basal ration was composed of: Ground yellow corn 76.35, Soybean oil meal (Expeller process) 17.50, Ground alfalfa hay 5.00, Iodized salt (NaCl) .50, and Calcium flour ($CaCO_3$) .65 per cent.

Young gilts grown on the above ration with and without extra alfalfa hay were bred and allowed to farrow. Invariably the gilts receiving the 5.0% alfalfa hay failed to suckle their litters sufficiently to allow normal growth. There seemed to be no inhibition of the reproductive function up to farrowing. The additional burden of lactation reflected the inadequacy of the ration in the suckling growing pigs. They became thin and emaciated and in many cases died before reaching weaning age. The inclusion of 15.0% alfalfa meal in the ration adequately fortified the ration to permit normal reproduction and lactation in the sow.

To determine the specific deficiency or deficiencies of this ration an extensive series of experiments were made with rats. Failure of reproductive function occurred during fetal development or during the suckling period. Intrauterine hemorrhage invariably occurred which resulted in resorption or death from toxemia if the fetuses were large. If young were born, lactation was inadequate and the young usually died. Alfalfa meal added at the 15% level instead of the 5% level allowed normal reproduction and lactation, even in some instances through the second generation. A Skelly B extract of alfalfa did not alleviate the condition, but the residue was equal to or superior to alfalfa meal. Addition of casein, choline, pantothenic acid, riboflavin and pyridoxine plus Skelly B residue gave excellent results both in reproduction and lactation.

THE DEFICIENCIES OF NON-LEGUMINOUS ROUGHAGES FOR BREEDING EWES. C. L. Shrewsbury, Claude Harper, F. N. Andrews and M. R. Zelle, *Purdue University.*

Previous experiments at the Purdue Station during the past five years have shown that non-leguminous roughages do not satisfactorily meet the requirements of gestation and lactation of breeding ewes. When alfalfa hay has been fed the difficulties have been obviated. Past attempts to improve an oat straw and corn silage ration by the addition of soybean oil meal, steamed bone meal, calcium carbonate, potassium iodide and combinations of these materials have been unsuccessful. During the past year high quality protein, vitamin A concentrate, and alfalfa hay ash were used to supplement the oat straw ration. The addition of casein or casein and vitamin A resulted in improved maintenance of the ewes. Lactation studies

show that ewes receiving alfalfa hay have consistently produced the most milk, that those receiving oat straw or oat straw supplemented with alfalfa ash or vitamin A have produced the least milk and that the ewes receiving casein or casein and vitamin A were much superior to the oat straw lot but not quite equal to the alfalfa hay lot in milk production. The growth of the lambs was closely correlated with the milk production of the ewes. The addition of casein to the oat straw ration improved the wool clip but it did not equal alfalfa hay in this respect. The results indicate that protein, minerals and vitamin A are not the only deficiencies of the non-leguminous ration and that alfalfa contains additional substances which are essential for optimum results.

Animal Breeding Section

C. L. Cole, *chairman*

THE INHERITANCE OF DWARFISM IN SHEEP. Ralph Bogart and A. J. Dyer, *University of Missouri.*

Several lambs which are dwarf and die within a month after birth have been produced by one strain of Southdown sheep. The lambs are short legged, thick through the shoulders, and have a bulging forehead. They gain in weight for a short time and become "puffy" fat in appearance but die when only a few weeks of age.

Histological studies of the thyroid gland indicate that a disturbance of this gland is associated with the dwarf condition. Toxic goiters have been observed in every lamb examined. Thyroxin therapy was attempted with little or no success in correcting the abnormality. One dwarf lamb that received desiccated thyroid, one-half grain daily, lived to an age of nine weeks, whereas, all the other dwarf lambs died before they were 5 weeks of age.

Many of the dwarf lambs also have a short under jaw but, in this strain, dwarfism and short under jaws each occurred without the other. There is likely a close linkage of the two because seven of the eight dwarf lambs had short under jaws and one was a dwarf with normal jaws. One other lamb was not a dwarf but had a short under jaw.

The abnormality is apparently a simple recessive lethal. In this strain of sheep 22 per cent of all lambs produced were dwarf. The data demonstrate that the gene is not sex-linked because normal (carrier) animals produced male and female dwarfs in equal numbers. (Mo. Exp. Sta. Journal Series No. 775.)

CONCERNING THE FATE OF EXPERIMENTALLY PRODUCED MULTIPLE PREGNANCIES IN SHEEP. L. E. Casida and E. J. Warwick, *University of Wisconsin.*

Gonadotrophic extracts were used to induce super-ovulation in 25 ewes. Termination of the treatments coincided with natural estrus. Observations were made by laparotomy on different animals at 2 to 5 days, 14 to 27 days, and 30 to 37 days following insemination. The numbers of ewes found to be pregnant in the different intervals were 6 out of 7, 8 out of 10 and 5 out of 8 respectively. The average number of corpora lutea per ewe ranged from 20.8 to 24.6. An average of 9.2 normal embryos was found during the first period; this declined to 3.8 during the second period, and to 0.8 per pregnant ewe in the third. The average number of dead or degenerating embryos which were recovered varied from 3.6 to 4.0 during the three intervals. The crown-rump length of normal appearing embryos coincided very closely with the data on normal development found in the literature.

This work has demonstrated the fertilizability of eggs produced experimentally by gonadotrophic hormones. Multiple pregnancies were not found to continue as such beyond 27 days, however. Two questions are raised which must be submitted to experimental attack: (1) Does hyper-stimulation of the ovary produce abnormalities in the egg which lead to inherent weakness and death of the embryo? (2) Is the uterine environment, conditioned by hyper-stimulation of the ovary, unsuited for the development of a large number of embryos?

GENETIC RESISTANCE TO BRUCELLOSIS IN SWINE. H. S. Cameron, P. W. Gregory and E. H. Hughes, *University of California, Davis.*

During investigations on contagious abortion in swine due to *Brucella suis*, two sows and

a possibly related boar evidenced resistance to attempts to artificially infect them. The criterion for resistance was an inability to react to the agglutination test for the disease following the attempt. A breeding program was initiated to determine if the resistance could be transmitted to the offspring. To date, a total of 135 progeny have been tested for resistance by administering the organism orally and blood testing three weeks later. Of these, 104 were classified as resistant and 12 as susceptible. The remaining 19 could not be definitely classified because of intermediate agglutination reactions. Most of these, however, tended towards resistance rather than susceptibility. Controls consisted of a group of weaned pigs from another source. This group showed a high incidence of susceptibility.

Bacteriological examinations at autopsy in a number of progeny showed that the genetic factor was an ability to resist the organism rather than an inability to produce agglutinins against it. The results indicate that certain individuals harbor a resistance to *Brucella* that is transmissable to the progeny. Sufficient types of mating are not yet available to allow an analysis to determine the method of transmission.

IDENTICAL TWIN CALVES MAINTAINED UNDER SIMILAR ENVIRONMENTAL CONDITIONS. A. B. Chapman and L. E. Casida, *University of Wisconsin.*

A pair of grade Holstein twin calves were diagnosed as identical by the following criteria; same sex (male), similarity of color markings, single corpus luteum and the uterine horn of pregnancy being on the same side in the dam, similarity of the nose prints and same reaction of the red blood cells to thirty different cellular reagents.

A moderate attempt was made to keep and manage the calves similarly. They were weighed and seventeen different body dimensions were taken at approximately monthly intervals from three to seven months of age inclusive and at nine months and again at slaughter, when sixteen months of age. The extremely close agreement between the calves in the descriptive measurements indicates that the early body size and growth rate were dependent almost entirely upon genetic constitution and easily controllable environment and not upon unexplainable or chance factors of development.

The data obtained for the weights of body parts and meat cuts at slaughter indicate that the influence of uncontrollable environmental factors as compared to genetic and controllable factors varies considerably from one body part or meat cut to another.

The total area of black spots and general location of pigmented areas on each calf were rather similar. The shape and size of the individual black spots, however, were not essentially alike.

EXPERIMENTAL DESIGN FOR TESTING INBRED LINES OF SWINE. G. E. Dickerson, *U. S. Department of Agriculture, Ames, Iowa.*

The following conclusions are reached from a study of the quantitative influence of various factors on the numbers of animals needed for *statistically* significant results from line-testing experiments which may be conducted in the Regional Swine Breeding Laboratory: 1. It will probably take more than twice as long and considerably more work to demonstrate significant differences in productivity of sows than in 180-day weight or conformation score. 2. Between 30 and 50 per cent of inbreeding is the practical optimum for comparisons of different inbred lines, topcrosses, and linecrosses, since the requirements for significance are reduced little by further inbreeding. 3. The numbers of animals required for significance are largest for differences between topcrosses, about half as large for those between unrelated linecrosses, and about one-third as large for those between the inbred lines themselves. Only slightly larger numbers are needed for differences of comparable size in specific comparisons between topcrosses and outbred stock than in those between different topcrosses. 4. To expect significant differences between inbred lines, topcrosses, or linecrosses, related inbred lines must be more highly inbred than unrelated lines by an amount nearly as great as the average inbreeding which would have resulted from mating the foundation animals of one line to those of another. 5. In comparing groups having no parents in common, fewest litters are needed for significance in the analysis itself if no parent has more than one litter. However, the cost of sire service, the mating system, and other factors, must be considered in arriving at the experimental plan

which will provide significant results most economically. 6. The differences produced by inbreeding are largest between the inbred lines themselves, $\sqrt{\frac{1}{2}}$ times as large between unrelated linecrosses, and $\frac{1}{2}$ as large between topcrosses. Even if the lines should become completely homozygous, differences between unrelated linecrosses will not exceed those between individuals in a non-inbred population. These estimates are for additively genetic differences in unselected populations.

THE EFFECT OF SEX ON THE DEVELOPMENT OF THE PIG. II. STUDIES OF SEX HORMONE DIFFERENCES BETWEEN LINES. W. W. Green, J. R. Rash, Jr. and D. L. Dailey, *University of Minnesota.*

Androgenic and estrogenic substances have been found in boar urine. The samples were secured by placing pigs in screen bottom crates for a period of 48 hours. The urine was hydrolyzed and extracted with a Koch benzene extractor. Androgenic and estrogenic fractions were separated by NaOH. Assays were made by use of colorimetric and capon technics. A correlation of 0.8 ($p=7.01$) was found between these methods. One 48-hour sample (mouse vaginal smear technic) contained 71γ estrone equivalent.

A difference in androgen excretion apparently existed among boars of similar age but different lines of breeding. Three boars (age over 6 months) of Line I excreted an average of 0.555 capon units/48 hours (6 samples) and two boars (age over 6 months) of Line II averaged 1.464 C.U./48 hours (5 samples). Weekly samples were secured from boars from 10 weeks to 6 months of age and the samples were assayed colorimetrically. Two boars of Line I (19 samples) averaged 2,122γ androsterone equivalent. Three pigs of Line III (30 samples) averaged 4,523γ androsterone equivalent (3 samples). In addition 2 boars (age 10–25 weeks) representing a cross of Lines I and II averaged 2,368γ androsterone equivalent (14 samples). Twenty other boars of the same lines of breeding from whom a total of 174 samples have been secured up to the present time seem to be confirming the above results. The exact relationship between androgen excretion and virility has not been so far determined.

CONCERNING FACTORS INVOLVED IN EXPERIMENTAL INITIATION AND MAINTENANCE OF PREGNANCY IN THE JUVENILE FEMALE. R. L. Murphree, E. J. Warwick and L. E. Casida, *University of Wisconsin.*

Ova have been matured in female rabbits 80 to 90 days of age by hyperstimulation with gonadotrophic extracts of sheep anterior pituitary. The does were inseminated and studies made of the viability of the resulting embryos. Twenty-two does examined 2 to 3 days following insemination yielded an average of 16.7 normal appearing embryos, 8 others at 5 to 9 days showed an average of 8.3 normal embryos, and of 11 allowed to go further only one showed definite implantation sites at 10 days and later.

In an effort to determine if modification of the uterine environment would prolong the life of the embryos, does have been treated with progesterone and Progynon-B following insemination. Data obtained indicate that these substances prolonged the life of the embryonic sites, but thus far no significant increase in the number of young produced at term has been obtained.

In order to test the viability of eggs from stimulated does, data have been obtained upon their transplantability into adult host does as compared to that of naturally matured eggs. The data showed no difference, but the percentage success in transplanting both types of eggs has been relatively low. The results suggest that the instability of multiple pregnancies produced as a result of hyper-stimulation of the ovaries is more likely due to an aberrant hormonal condition in the genital tract than to abnormalities induced in the egg during maturation.

SEXUAL DEVELOPMENT IN LARGE AND SMALL TYPE POLAND CHINA HOGS. Ralph W. Phillips and John H. Zeller, *United States Department of Agriculture.*

Thirty-five large and 15 small type boars were castrated at 5 to 40 weeks of age. Comparisons of weight and volume of testes, diameter of tubules, presence of spermatozoa and proportion of weight of testes to body weight showed no measurable differences between the two types.

Twenty-nine large and 14 small type gilts were observed daily from weaning for the first

occurrence of estrus. Age at first estrus ranged from 163 to 219, and averaged 193.3 days in the large type. The range was 178 to 259 days in the small type and the average was 221.8.

A higher level of prolificacy in the large type is indicated by Hetzer and Brier (Proc., Am. Soc. An. Prod., 1940), who report the average litter size of large and small types to be 7.4 and 5.8, respectively. Observation indicates greater libido in the large type. It is not certain whether this is a reflection of a greater tendency of the small type to fatten, or whether a basic difference in level of sexual activity exists. Findings summarized above indicate a different rate of development, between the two types, in the female but not in the male. This may possibly reflect a difference in sensitivity of the sexes to gonadotropic hormones, since precocious development of the ovaries has been attained in females of many species, while attempts to stimulate the testes have met with relatively little success.

Saturday Noon Session

R. M. Bethke, *presiding*

WORK OF THE RESEARCH LABORATORY OF THE AMERICAN MEAT INSTITUTE. H. R. Kraybill, *American Meat Institute.* (No abstract available)

SUMMARY OF THE MINUTES OF THE THIRTY-FOURTH ANNUAL BUSINESS MEETING OF THE AMERICAN SOCIETY OF ANIMAL PRODUCTION

The thirty-fourth annual business meeting of the Society was held on November 29, 1941, at 2:00 P.M. in the Hotel Sherman, Chicago, Illinois. W. H. Peters, president of the Society, presided.

The Secretary-Treasurer's report was presented showing a net membership of 473. During the year 38 new members were added and 22 memberships were withdrawn or dropped. The Treasurer's report showed a balance of $3,650.54.

A special auditing committee consisting of Arthur L. Anderson and Ralph Bogart reported the accounts of the Treasurer to be accurate in all respects.

The following substitutes for definitions published in the 1940 Record of Proceedings were presented by the Committee on Investigation and with these substitutions the list of definitions was approved by unanimous vote:

Outcross—A cross of relatively unrelated animals within the same breed or variety.

Heterosis (or hybrid vigor)—The superiority over the better parent that is exhibited by the progeny. This applies to the progeny from the crossing of strains, varieties, breeds or species. The committee suggested that this terminology is sufficiently inclusive to describe various types of crosses without the use of the term "hybrid."

Approval was also given to a recommendation of this Committee that two special committees be appointed (1) to make a critical study of existing show ring standards and the relation between criteria used in judging and the performance of animals and (2) to consider the preparation and publication of monographs on special topics of major interest and value to the livestock industry.

Two reports from Sub-committees of the Special Committee on the Evaluation of Feeds were recommended to the Society for publication. These reports relate to the evaluation of feeds on the basis of digestible and metabolizable nutrients and net available nutrients. It was stated that the report of the Sub-committee on Total Nutrients will serve as a basis of continued consideration of this subject by the Special Committee.

Included in the report received from the Special Committee on Registration of Animals Produced by Artificial Insemination and Recognition of New Breeds was a suggestion that the two organizations set up to record the pedigrees of Tennessee Walking horses and Quarter horses be added to the list of breed associations already generally recognized.

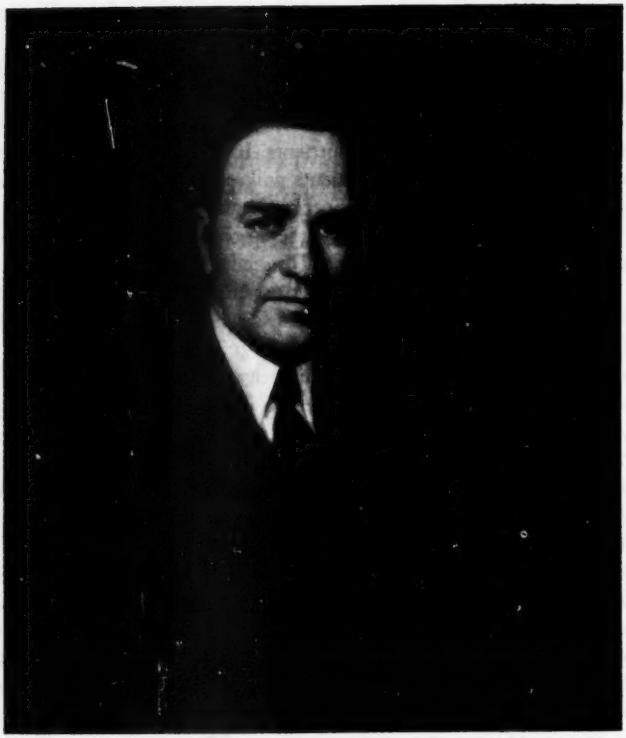
The Special Committee on Pasture Investigations recommended that its name be changed to "Special Committee on Pasture and Range Investigations," and that its program should include (1) the formulation of a pasture program for the annual meeting of the Society, (2) the preparation and distribution of summaries on pasture research techniques and research results, and (3) cooperation with the pasture committees of the American Society of Agronomy and the American Dairy Science Association.

The actions of the Executive Committee with reference to the editorial policies and other matters pertaining to the JOURNAL OF ANIMAL SCIENCE were approved. Unanimous approval was also given to a recommendation of the Executive Committee that the President be instructed to appoint a committee to revise the constitution to conform with present activities and policies of the Society; also, that all membership applications be considered by the Executive Committee until such time as different provisions for election to membership are made in the constitution.

Announcement was made of the appointment of Dr. Ralph W. Phillips as permanent editor of the JOURNAL OF ANIMAL SCIENCE.

The following officers were elected for 1942:

President . . . . . R. M. Bethke
Vice-President . . . . . L. A. Maynard
Secretary-Treasurer . . . . . A. D. Weber



Edwin A. Trowbridge

Reproduction of portrait presented to the Saddle and Sirloin Club by the American Society of Animal Production on November 30, 1941. The presentation was made by the Society at a dinner held for its Honor Guest, Edwin A. Trowbridge, in the Saddle and Sirloin Club, Chicago, Illinois.

EDWIN A. TROWBRIDGE

Honor Guest—1941

E. A. Trowbridge was reared in Buffalo county, Wisconsin, receiving his preliminary education in the public schools of that county. He was graduated from the College of Agriculture of the University of Wisconsin in 1906. Later in the same year he joined the staff of the University of Missouri as an instructor in animal husbandry.

An examination of the early record of this youthful newcomer to Missouri indicates that he wasted no time in getting down to work or in getting acquainted with the farmers and stockmen of his adopted state. It was only four years later that he became head of the department of animal husbandry, a position which he has held with distinction for 31 years.

Professor Trowbridge is now known the country over as a judge in state, regional, and national livestock shows and as an authority in the livestock industry. He is himself a farm owner and livestock producer and a director of the American Royal Livestock Show of Kansas City.

Even greater, however, are the contributions made by Professor Trowbridge as a teacher, associate, and friend. To the thousands, young and old, whom he has influenced, he has ever been the ardent advocate of livestock farming as a noble and satisfying way of life. Constant in his faith in good livestock and able husbandry, he has insisted always that this occupation be entered into as a lifework and as a means of making a notable contribution to the welfare of mankind.

In his own community, Professor Trowbridge is active in civic affairs. A Methodist, a Free Mason, and a Kiwanian, he works faithfully on boards and committees and in other positions of responsibility. For sixteen years he has been a district and area committeeman in Boy Scout work.

Professor and Mrs. Trowbridge (formerly Miss Alice Goddard of Mondovi, Wisconsin) have two sons, Edwin A. Jr. and Leigh M. Both sons are graduates of the University of Missouri, are married and are identified with the agricultural industry; the elder is with Thos. E. Wilson & Company at Chicago and the younger with the International Harvester Company at Kansas City.

MEMORIALS

CARL L. ALSBERG

A little over one year ago, on October 31, 1940, the world of science lost one of its most brilliant and stimulating personalities, Dr. Carl L. Alsberg. Trained as a biochemist, he taught at Harvard, served in the Bureau of Plant Industry from 1908 and in 1912 became chief of the Bureau of Chemistry in the United States Department of Agriculture. In 1921 he was made a director of the Food Research Institute at Stanford University and in 1938 became director of the Giannini Foundation and professor of agricultural economics at the University of California. He was the "complete scientist," as at home in the social sciences as in the natural sciences.

HOWARD HACKEDORN

Howard Hackedorn was born in Maryville, Missouri, December 16, 1886. He died on June 30, 1941. Professor Hackedorn graduated from the University of Missouri in 1910, and later continued his education at the University of Illinois. From 1910 to 1918 he was a staff member at the University of Missouri. Marked success attended his efforts as a teacher and in research, particularly in sheep production. Head of the Animal Husbandry Department of the State College of Washington since 1918, Professor Hackedorn made many valuable contributions to the livestock industry. He was instrumental in organizing the Inland Empire Shorthorn Breeders' Association and the Northwest Hereford Breeders' Association. He leaves a host of friends and co-workers who will miss his genial personality and his wise counsel.

MAX KRISS

Dr. Max Kriss, Professor of Animal Nutrition in the Pennsylvania Institute of Animal Nutrition, died of coronary thrombosis November 16, 1941.

Born May 15, 1894, at Ostropol, Russia, he came to the United States in 1910, and earned his own way through college.

Dr. Kriss became one of the world's leading authorities on the energy metabolism and the ventilation requirements of farm animals, and the influence of nutrients, especially the amino acids, on the production of heat.

Ever a profound student, and a modest and kindly gentleman, he enjoyed the deep respect and the affectionate regard of all who knew him.

CON S. MADDOX

Con S. Maddox was born at Linneus, Missouri, August 11, 1903. He died May 2, 1941. He graduated from the University of Missouri 1925, and did graduate work there and at Washington State College. He supervised experimental cattle breeding at Sni-A-Bar Farm for a year, served a year as 4-H Club Agent at the University of Nebraska, then four years as County Agent in South Dakota, after which he went to Washington State College as Extension Animal Husbandman where he was serving at the time of his death. He was Secretary of the Washington Cattlemen's Association and Superintendent of the Spokane Junior Livestock Show. Exceedingly capable in his field, he made a special contribution in preservation of meat by freezing. He leaves a record of a fine character, fine ideals and fine accomplishment in improvement of farm living.

NEWS AND NOTES

The National Live Stock and Meat Board will place grants and establish fellowships through the National Research Council for the purpose of increasing the present knowledge of nutrition. Grants may be made for either fundamental or clinical research on the nutritional properties of meat, meat products and animal fats, and the importance of these nutrients to human health and welfare. This fund, limited in amount, will become available on July 1, 1942. Applications will be received until March 1, 1942. Application blanks may be obtained from the Division of Biology and Agriculture, the National Research Council, 2101 Constitution Avenue, Washington, D. C. In addition to a statement of the problem and research plan or program, the Committee in charge desires information regarding the method of attack proposed, the institutional support which will be given the investigation and the uses to be made of the sum requested. No part of a grant may be used by the recipient institution for administrative expenses.

John M. Cooper, superintendent of the Southwestern Range and Sheep Breeding Laboratory, Fort Wingate, New Mexico, is on six months' leave of absence as a member of a committee making a survey of sheep production possibilities in Ecuador.

Fred F. McKenzie, formerly of the staff of University of Missouri, is now head of the animal husbandry department, Utah State Agricultural College, Logan.

L. N. Hazel recently completed graduate work at Iowa State College and is now agent in animal husbandry at North Platte, Neb., representing the Regional Swine Breeding Laboratory.

Marvel L. Baker, formerly at North Platte, is now in charge of animal husbandry research in the Nebraska Experiment Station at Lincoln. C. F. Reinmiller now has charge of the experimental work at North Platte.

M. E. Ensminger, formerly of the staff of Massachusetts State College, is now head of the animal husbandry department, Washington State College, Pullman. Mr. Hecht, a graduate of the University of Missouri, succeeds Dr. Ensminger at the Massachusetts State College.

Jay L. Lush, of the Iowa State College, was on leave from October 12 to December 11 while traveling in Argentina and teaching a special course in animal breeding at Minas Geraes, Brazil.

H. L. Garrigus, for many years head of the animal husbandry department at the University of Connecticut, Storrs, recently retired and is now emeritus professor of animal husbandry. F. C. Daugherty, formerly of the North Dakota Agricultural College, is now acting head of the department.

W. B. Young, formerly of the animal husbandry department, University of Connecticut, is now director of the 2-year school of agriculture and short courses at the same institution.

M. H. McDonald, a graduate of Iowa State College and former instructor in animal husbandry in a North Dakota high school, has succeeded F. C. Daugherty at the North Dakota Agricultural College.

R. S. Glasscock recently completed work for the Ph.D. degree at the University of Illinois and is now doing resident teaching and research work at the N. C. State College of Agriculture, Raleigh.

W. E. Krauss became head of the dairy industry department at the Ohio Experiment Station, Wooster, January 1, 1942.

W. P. Garrigus is now head of the animal industry department, University of Kentucky, Lexington, vice E. S. Good who retired to an emeritus position on July 1, 1941.

Wilson Wright, a graduate of the University of Wisconsin and formerly on the staff of University of Illinois, is now at the University of Kentucky.

W. G. Kirk, of the University of Florida and formerly located at Gainesville, is now in charge of the Range Cattle Experiment Station with headquarters at Wauchula.

O. Burr Ross, a graduate of the University of Nebraska, is now an instructor at the University of Wisconsin, in charge of swine work.

John Ashton, formerly of the University of Missouri, and for several years holding a teaching position at the Texas A. & M. College, spent last summer in Central America studying agricultural problems.

Walter C. Coffey is now president of the University of Minnesota after serving as acting president for some time.

W. S. Rice, a graduate of the University of Nebraska and for many years on the resident teaching staff of the University of Georgia at Athens, has succeeded Ralph E. Davis, as extension animal husbandman in the same institution.

M. L. Buchanan, formerly of the West Virginia University at Morgantown, has succeeded W. S. Rice on the teaching staff of the University of Georgia.

Walter Tolman, formerly assistant extension animal husbandman at the University of Nebraska, Lincoln, has been appointed extension animal husbandman at the Washington State College, Pullman, to succeed Con S. Maddox, deceased.

D. T. Batchelder, former extension specialist in animal husbandry at the University of California, Berkeley, has been transferred to dairy extension work in the same institution and was succeeded by Vard M. Shepard, a graduate of the University of Minnesota, who had extension experience in Minnesota and vocational agriculture and livestock marketing experience in California.

Ross H. Miller, a graduate of the University of Nebraska and formerly of the staff of that institution, and that of Oregon State Agricultural College, and Montana State College, is now a field man for the American Hereford Cattle Breeders' Association.

Kenneth C. Ikeler, formerly of the staff of the University of Maryland, has been appointed superintendent of the Squaw Butte Range Station at Burns, Oregon. This station is operated jointly by the Oregon Experiment Station and the Grazing Service of the Department of the Interior.